Volume I

FINAL

ENVIRONMENTAL STATEMENT

PROPOSED FOOTHILLS PROJECT

U. S. Department of the Interior

Bureau of Land Management

FINAL

ENVIRONMENTAL IMPACT STATEMENT

Proposed

FOOTHILLS PROJECT

Bureau of Land Management

Department of the Interior

George L. Turcott

Acting Director, Bureau of Land Management

SUMMARY

( ) Draft Environmental Statement+ (X) Final Environmental Statement

Department of the Interior, Bureau of Land Management

1. Type of Action: (X) Administrative ( ) Legislative

2. Brief Description of Action: The Board of Water Commissioners for the city and county of Denver propose to construct, operate, and maintain water diversion facilities on federally managed lands on the South Platte River 25 miles southwest of Denver, Colorado, as a part of the proposed Foothills Project. The project would also include a water treatment plant with an ultimate capacity of 500 million gallons per day and a conduit distribution system extending into the Denver metropolitan area. Sources of water would include both the South Platte River and the Blue River via Dillon Reservoir and the Harold D. Roberts Tunnel.

3. Summary of Environmental Impacts: Results of the proposed action include the loss of 1.7 miles of free-flowing river, 35 bighorn sheep, most of the historical narrow gage railbed features, and about 18,000 to 36,000 recreation visits to the South Platte Canyon. Also 1,753 tons of additional sediments would be placed into the South Platte drainage. The proposed action would also provide for adequate municipal and industrial water in the Denver metro area until sometime after 2001, positively impacting that area by maintaining existing lifestyles until that time.

4. Alternatives Considered:

   A. Major Alternatives
      1. Chatfield Alternative
      2. Upstream Dam Alternative
      3. Water Conservation Alternative
      4. No Action Alternative
   B. Minor Alternatives
      1. Lower Dam
      2. Elevator Access to the Dam Crest
      3. Fourteen-foot Roadway with Turnouts
      4. Parallel Bridge
      5. Underground Powerlines and Telephone Lines
   C. Raw Water Alternatives
      1. Concept A
      2. Concept B
      3. Concept C

5. Comments Were Requested from the Following: See attached list. (Those who provided comments are indicated by an asterisk.)

6. Date Statement Made Available to CEQ and the Public:

   Draft Statement: August 5, 1977
   Final Statement:

*National Advisory Council on Historic Preservation
Department of Agriculture
    *Forest Service
    *Soil Conservation Service
Service Department of Commerce
*Department of Defense
    *Corps of Engineers
*Environmental Protection Agency
*Federal Regulatory Energy Commission (formerly the Federal Power Commission)
*Department of Health, Education and Welfare
*Department of Housing and Urban Development
*Department of the Interior
    *U.S. Fish and Wildlife Service
    *U.S. Geological Survey
    *Bureau of Mines
    *National Park Service
    *Bureau of Reclamation
    *Bureau of Outdoor Recreation
Department of Transportation
Water Resources Council
River Basin Commission
    Arkansas River
    *Upper Colorado River
    Missouri River
*State Historical Society of Colorado
*Colorado Department of Health
    *Division of Water Quality
    *Division of Air Pollution Control
*Colorado Land Use Commission
*Colorado Department of Natural Resources
    *Colorado Division of Wildlife
    *Colorado Division of Water Resources
    *Colorado Division of Parks and Outdoor Recreation
*Colorado State Planning Division
State Cleaninghouses
    State of Arizona
    State of California
    State of Colorado
    State of Utah
*Colorado Open Space Council
Institute of Ecology
*League of Women Voters
Resources Defense Council
*Trout Unlimited
*Sierra Club
*Rocky Mountain Bighorn Sheep Society
Northern Colorado Educational Board of Cooperative Services
*Denver Regional Council of Governments

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*Responses Provided

*City of Aurora
    Department of Planning and Community Development
*City of Broomfield
    Broomfield Planning Staff
*Citizens for Sensible Water
*City of Denver
    *Department of Planning
*Environmental Defense Fund
*City of Longmont
    *Planning Department
 Pikes Peak Council of Governments
*Adams County Commissioners
*City of Thornton
*City of Wheatridge
*Boulder County Planning Department
*City of Lakewood
*South Platte Canyon Preservation Council
 Jefferson County Historical Society
 Douglas County Historical Society
 Park County Historical Society

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DESCRIPTION OF THE PROPOSED ACTION

INTRODUCTION

Summary

The Board of Water Commissioners for the city and county of Denver (also known as the Denver Water Department and hereinafter referred to as the Denver Water Board (DWB)) has applied to the appropriate U. S. Government agencies for the right to construct, operate, and maintain water-diversion facilities on federally managed lands along the South Platte River approximately 25 miles southwest from downtown Denver, Colorado (see Map 1-1 at the end of this chapter). Specific agencies are listed in the Governmental Actions section of this chapter. These facilities are a part of a larger DWB proposal known as the Foothills Project.

The project would involve 60 acres of national forest lands and 51 acres of lands administered by the Bureau of Land Management. The project would increase the DWB nominal treatment capacity by 125 million gallons per day (mgd) with the capability of expansion to 500 mgd. All components of the proposed Foothills Project are designed to accommodate expansion to a capacity of 500 mgd in the event that population in the DWB treated water service area grows as projected and future additional raw water supplies are developed to satisfy the water needs of the growing population.

The proposed Foothills Project would expand the existing system and correct treatment deficiencies in the system. (Briefly, the problem the Foothills plant addresses is the distribution and treatment of available water supplies.) While nearly half of the Denver Water Board's treatment capacity is on the north end of the system, only 30 percent of the raw water is delivered to the north end of that system. Nearly three times the amount of available raw water flows into the Denver system from the south. Because there is no raw water intertie capability between filtration plants, the southern system must be the place where filtration capacity is added.

The Foothills Project would use water stored during peak spring runoff in the existing Antero, Eleven Mile Canyon, and Cheesman Reservoirs as well as direct flows from the rivers. As needed, west slope water from Dillon Reservoir would be released through the existing Roberts Tunnel and down the North Fork of the South Platte River to supplement direct South Platte reservoir releases. The water

would be diverted from the South Platte River by the proposed Strontia Springs Dam and Reservoir into a tunnel (Foothills Tunnel) and conduit (No. 26) system to the proposed treatment plant, about 3 miles northeast (see Map 1-2 at the end of this chapter).

Approximately 11 million kilowatt-hours of hydroelectric power would be generated annually at 125 mgd and 78 million kilowatt-hours generated annually at 500 mgd by the water near the terminal point of Conduit No. 26. Of this power, 8 million kilowatt-hours would be utilized at 125 mgd and 13 million at 500 mgd to operate the plant. "Raw" water would be treated and passed into another conduit (No. 27) for delivery to the Denver metropolitan area (see Maps 1-2, 1-3, and 1-4 located at the end of this chapter). A second identical conduit would be built parallel to Conduit No. 27 when the treatment plant is expanded to 500 mgd. The proposal also includes an emergency intertie conduit with the city of Aurora's raw water system.

Background and History

In the early 1900s, plans were devised to divert and use water from the Upper South Platte and Blue Rivers to serve customers in the Denver area. Use of these waters began with the construction of Cheesman Dam in 1905 and was expanded in the 1930s with the purchase of Antero Reservoir and the construction of Eleven Mile Reservoir on the South Platte system. In 1963, Roberts Tunnel and Dillon Reservoir were completed by the DWB for diversion of west slope water from the Blue River system to the east slope.

Serious plans for the proposed Foothills Project were initiated by the DWB during 1952-1955 with a preliminary survey of the Foothills Tunnel and the treatment plant site. In 1956, the DWB prepared the first plans for Strontia Springs Diversion Dam and purchased 200 acres for a treatment plant. In 1957, the route of proposed Conduit No. 27 to Denver was surveyed. In 1962, the DWB filed its original application for those parts of Strontia Springs Diversion Dam and Reservoir, Conduit No. 26, and the Foothills Tunnel on federally managed lands as a part of the proposed Foothills Project. A report to the DWB (Black and Veatch 1963) recommended completion of the first treatment plant unit in 1977.

In 1967, BLM issued a right-of-way permit (C-099597) which allowed the DWB five years to construct the Strontia Springs Diversion Dam and Reservoir, conduits, and tunnel. In 1973, the DWB requested and was granted an extension of time to submit an amended application based on changes in the original design and to complete construction. The letter from BLM granting the extension indicated the need for analysis of the action in compliance with Public Law (PL) 91-190, the National Environmental Policy Act of 1969 (NEPA). DWB studies

culminated in the Foothills Predesign Report in November 1973 and the Foothills Project Environmental Impact Assessment in April 1974. In January 1974 the DWB filed another request for a one-year extension of time to prepare and submit an amended filing and for three years to construct. After receiving these amended filings, BLM decided to comply with NEPA prior to acting on DWB's request.

An amendment to the original right-of-way permit was received from the DWB in November 1974. A new application for road access to the proposed dam site across federally managed land was filed in October 1974. From these applications, the Department of the Interior determined that the action as proposed could significantly affect the quality of the human environment and began preparation of this environmental impact statement, as required by Section 102(2)(C) of NEPA. In February 1975, the Department determined that this environmental impact statement should be project-specific in scope and consider the effects of construction and operation of the dam, reservoir, ancillary facilities in the canyon of the South Platte River, the treatment plant, and the water supply, along with delivery tunnels and conduits. BLM was designated lead agency to coordinate all inputs from federal agencies and prepare the draft environmental statement (DES).

This original draft environmental statement was filed with the Council on Environmental Quality (CEQ) in December 1975 and issued in January 1976. Public hearings were conducted February 19, 1976. On July 8, 1976, the Regional Solicitor issued a memorandum advising that the scope of the draft environmental statement was insufficient as a matter of law and recommended that the Secretary of the Interior postpone his decision on the Foothills proposal pending comprehensive analysis.

On November 1, 1976, the Assistant Secretary of the Department of the Interior for Land and Water Resources sent a memorandum to the Colorado State Director of the BLM outlining the requirement for a new draft environmental statement covering the proposed Foothills Project. A supplementary memorandum from Mr. Horton on December 27, 1976, further elucidated the requirement for an expansion of the existing draft statement for the express purpose of providing a sound basis for decision-making between the Department of the Interior, the State of Colorado, and the DWB. The scope of the potential impacts studied was enlarged to include the effects of the treatment plant being implemented at the 500 mgd level and a discussion of new sources of raw water needed to meet the 500 mgd capacity of the Foothills Treatment Plant.

GOVERNMENTAL ACTIONS

This section includes a description of actions required to approve or disapprove all or any part of the proposed action by issuing or not issuing a permit, grant, right-of-way, or license. Agencies discussed are the Bureau of Land Management, the United States Forest Service, the Federal Energy Regulatory Commission (formerly the Federal Power Commission), Corps of Engineers, the Advisory Council on Historic Preservation, and the Colorado Department of Health; each agency which would issue necessary grants or permits under their respective authorities.

Bureau of Land Management

The DWB has filed two right-of-way applications with BLM. The first application, dated October 4, 1974, and identified by serial number C-22081, is for the Platte Canyon Road. This right-of-way application was later amended to more highly define the road widths needed for the project. The second application, dated November 4, 1974, is an amendment of right-of-way C-099597 for the Strontia Springs Diversion Dam, Reservoir, and Foothills Tunnel.

The amendment would affect a right-of-way originally granted on April 20, 1967, using as authority the Act of February 15, 1901 (31 Stat. 790; 43 U.S.C. 959) as to public lands, and Section 1 of the Act of February 1, 1905 (33 Stat. 628; 16 U.S.C. 524) as to national forest lands.

Both of these Acts were repealed by Section 706 of the Federal Land Policy and Management Act of October 21, 1976 (90 Stat. 2793). Section 501 of the Act authorizes the Secretary of the Interior to grant rights-of-way over, upon, under, and through the public lands for the various purposes that would satisfy the DWB municipal water development plans described in their pending applications. While regulations have not been issued to implement Sections 501 through 511 of the Act with respect to rights-of-way, this is the authority under which DWB would be permitted to use public land for the Foothills Project.

Table 1-1 outlines the features included in the filed applications. The rights-of-way limits shown are preliminary estimates of the widths that would be permitted under Section 504(a)(1) through (4) of the Act.

TABLE 1-1

SUMMARY OF RIGHT-OF-WAY APPLICATIONS
ON BUREAU OF LAND MANAGEMENT LAND

Feature	Right-of-Way Limits	Area or Distance BLM Lands
Strontia Springs Dam, Reservoir	50 feet from marginal limits of maximum pool level	22 acres
Platte Canyon access road, including 1,696 feet on BLM land which would be inundated by the proposed reservoir 1/	50 feet each side of centerline	29 acres (12,629 feet)
Total		51 acres

1/ This right-of-way would also be used for powerlines and telephone lines.

If approved, the right-of-way grants would allow the DWB a reasonable but as yet undetermined time within which to construct the facilities described and give the DWB the right to operate and maintain those facilities for the duration of beneficial use. The grants would not give the DWB any kind of title in the lands involved. The interest granted would not allow the removal of any material except that necessary for the construction of the project.

If rights-of-way are granted, two other permits would be necessary: The Public Service Company of Colorado would file for an extension of a 13.2-kilovolt overhead powerline of about 2.8 miles from the South Platte Intake to the dam site, of which 1.4 miles would be on BLM land. Mountain Bell would file for extension of a telephone line over the same distance and attach to the same poles as the power company.

The final decision regarding such land use authorizations would consider environmental factors, land use criteria, and economic considerations. The final environmental impact statement including the actions applied for must be filed with the Environmental Protection Agency (EPA) for at least 30 days before a final decision can be rendered.

The decisions for the two rights-of-way (dam and road) lie with the Director of the Colorado State Office, BLM, with prior review and concurrence by the Director, BLM.

United States Forest Service

The DWB application to amend the right-of-way C-099597 for the Strontia Springs Dam, Reservoir and the Foothills Tunnel, which this environmental statement addresses, involves a right-of-way originally granted on April 20, 1967, by the BLM, under authority of Section 4 of the Act of February 1, 1905, (33 Stat. 628; 16 U.S.C. 524) as to national forest lands involved. This act was repealed by Section 706 of the Federal Land Policy and Management Act of October 21, 1976, (90 Stat. 2793). Section 501 of the Act authorizes the Secretary of Agriculture to grant rights-of-way over, upon, under, and through national forest lands for the various purposes that would satisfy the DWB municipal water development plans described in the application to amend C-099597. The U.S. Forest Service will determine if rights-of-way are to be approved, and if approved the appropriate permits will be granted. Table 1-2 depicts five probable rights-of-way.

Federal Energy Regulatory Commission

Pursuant to Part I of the Federal Power Act of June 10, 1920 (41 Stat. 1075) as amended, the Federal Energy Regulatory Commission is responsible for licensing non-Federal hydroelectric projects, located on streams over which Congress has jurisdiction, or projects which affect public lands and reservations of the United States. The DWB proposes to install hydrogenerators near the terminal point of Conduit No. 26 which would produce 1,050 to 1,600 kilowatt-hours of electrical energy (1,400 to 2,150 horsepower). The generators would also serve to dissipate the water force near the end of that conduit. Indications are that the generators would not be an essential element of the project because other mechanisms could be used for the same energy dissipation purpose without any cange in the overall project design.

TABLE I-2

SUMMARY OF PROBABLE RIGHT-OF-WAY APPLICATIONS ON NATIONAL FOREST LANDS

Feature	Probable Right-of-Way Limits	Area or Distance (U.S. Forest Service Lands)
Strontia Springs Reservoir	not to exceed 50 feet from marginal limits of maximum pool level	16 acres Dam,
Foothills Tunnel	25 feet each side of center-line	5 acres (4,457.86 feet)
Dam abutment road	25 feet each side of center-line	1 acre (848.83 feet)
Dam outlet works road	25 feet each side of center-line	1 acre (885.78 feet)
Platte Canyon 1/ access road (including 1,802 feet which would be inundated by the proposed reservoir)	25 feet each side of center-line	15 acres (12,870.45 feet)
Total		43 acres

1/ This right-of-way would also be used for powerlines and telephone lines.

At present, the DWB has not applied to the Federal Energy Regualtory Commission for a license to construct and operate the proposed Foothills hydroelectric plant. The DWB has indicated that, since this part of its proposed project is not dependent on other project components, it would not file the necessary application until a decision is reached by the BLM and the U. S. Forest Service (USFS) concerning rights-of-way. This plan would allow the Federal Energy Regulatory Commission about three years to act on the application for the license. The Federal Energy Regulatory Commission would reach a final decision based on the need for power production as well as environmental and economic factors.

Corps of Engineers

The Corps of Engineers is charged with administration of Section 404 of the Federal Water Pollution Control Act (PL 92-500). Section 404 of that Act (33 USC 1344) requires a permit be obtained from the Corps prior to the discharge of any fill material into a navigable stream. Under present definitions, a dam is considered fill material and the South Platte River is a navigable stream. In addition, the access road work along the South Platte River below the dam will cause other fill material to be deposited in that stream as well as the crossing of Plum Creek by Conduit No. 27 and the second conduit. Therefore, the DWB must obtain a permit before it can begin these construction activities.

Other construction activities deemed necessary by BLM's mitigating measures as presented in Chapter 4 of this document will require separate 404 permit applications by the DWB.

Colorado Department of Health

Water Quality

During construction of the proposed Foothills Tunnel and Strontia Springs Dam in the South Platte Canyon, and the construction of Conduit No. 27 and the second conduit, the DWB expects a certain amount of water pollutants to be generated. This amount could possibly exceed State and Federal stream standards established as a result of the Federal Water Pollution Act of 1972 (PL 92-500) and amendments. In order to comply with this Act and Colorado Department of Health regulations, the DWB or its contractor(s) must apply for a stream discharge permit at least 180 days prior to the expected discharge. The application must include a map or other means of

identifying the possible points of discharge, expected pollutants, and proposed treatment. The Colorado Department of Health, Water Quality Control Division, will evaluate the proposed treatment in relation to the type of pollutants expected and determine whether the treated water would meet standards established by the state in cooperation with the EPA through the National Pollutants Discharge Elimination System. The permit, if issued, would establish limitations of pollutants expected.

Enforcement of the permit by the state would involve periodic water testing at the identified discharge points on the South Platte River. If the limitations imposed on the expected pollutants were exceeded, the state would seek to have the situation corrected immediately. If no corrective measures were taken voluntarily, legal action could be taken to stop construction until better treatment would be provided.

The Environmental Protection Agency also has enforcement authority similar to that of the Colorado Department of Health and could seek corrective measures in a similar manner.

Air Quality

During construction of the proposed Foothills Tunnel and Strontia Springs Dam in the Waterton Canyon, the DWB expects a minimal amount of air pollutants to be generated. These will be in two forms: dust from earthmoving operations and emissions from earthmoving vehicles. These amounts are expected to possibly exceed state air pollution standards at least for short time periods. In order to comply with the Colorado Department of Health regulations, the DWB or its contractor(s) must apply for the following air pollution emission permits (Colorado Department of Health Memorandum, 1977):

Strontia Springs Dam. Excavation for access area, reservoir and dam fill; fugitive dust emission (Regulation No. 3; Regulation No. 1, Section II.D.).

Stevens Gulch. Concrete batching operations; point source emission permit (Regulation No. 3).

Stevens Gulch. Four-acre staging area; fugitive dust emission permit (Regulation No. 3; Regulation No. 1, Section II.D.).

Chatfield area. Gravel mining, crushing, screening (if not an existing permitted or grandfathered source); point source and fugitive dust emission permit (Regulation No. 3; Regulation No. 1, Section II.D.).

Platte Canyon Road. 13,900 feet of road, 3,000 feet new; gravel with Pentaprime application; 20 trucks per day plus construction workers; fugitive dust emission permit (Regulation No. 3; Regulation No. 1, Section II.D.).

Tunnel Excavation. 102,000 cubic yards to be excavated and deposited on prescribed areas along Little Willow Creek, 30 level acres at East Portal of Tunnel; fugitive dust emission permit (Regulation No. 3; Regulation No. 1, Section II.D.).

Foothills Treatment Plant. Six acres to be disturbed, 2,699 feet of road from south to use crushed rock; fugitive dust emission permit (Regulation No. 3; Regulation No. 1, Section II.D): activated carbon storage and handling system; point source emission permit (Regulation No. 3).

Conduit No. 27. 115 acres total land disturbance: unsurfaced bladed road constructed parallel to Conduit No. 27, fugitive dust emission permit (Regulation No. 3; Regulation No. 1, Section II.D.).

Existing Douglas County gravel roads 5 and 7 used for access south from Kassler; increase in traffic may require dust control plan pursuant to Regulation No. 1, Section II.D.

If the controlled emissions from a single or cumulative sources will exceed 25 tons per year, a period of public comment is required (Air Pollution Control Regulation No. 3, Section G.). Compliance with the applicable performance and ambient air quality standards must be demonstrated in order to secure a permit.

Enforcement of the permit by the state would involve periodic emission testing at the nine sites identified in the project area. If the limitations imposed on the expected pollutants were exceeded, the state would seek to have the situation corrected immediately. If no corrective measures were taken voluntarily, legal action could be taken to stop construction until better treatment were provided.

Local Governmental Agencies

Prior to construction of principal project features, DWB might have to obtain special land use permits from four counties and from one incorporated city.

Authorizing actions are summarized in Table 1-3.

TABLE I-3

SUMMARY OF AUTHORIZING ACTIONS

Project Component	Required Authorization	Responsible Federal, State, or Local Agency
Dam, Reservoir, and Tunnel	Right-of-way permit	Bureau of Land Management
Dam, Reservoir, and Tunnel	Right-of-way permit	U.S. Forest Service
Dam, Reservoir, and Tunnel	Hydropower generation license	Federal Energy Regulatory Commission
Dam, Reservoir, and Tunnel	Section 404 permit	Corps of Engineers
Dam, Reservoir, and Tunnel	Sec. 106 Determination	Advisory Council on Historic Preservation
Dam, Reservoir, and Tunnel	Water quality certification and discharge permit	Colorado Department of Health
Access Roads	Right-of-way permit	Bureau of Land Management
Access Roads	Right-of-way permit	U.S. Forest Service
Access Roads	Section 404 permit	Corps of Engineers
Access Roads	Sec. 106 Determination	Advisory Council on Historic Preservation
Access Roads	Water quality certification	Colorado Department of Health
Powerlines and Telephone Lines	Right-of-way permit	Bureau of Land Management

TABLE 1-3

SUMMARY OF AUTHORIZING ACTIONS (cont.)

Project Component	Required Authorization	Responsible Federal, State, or Local Agency
Powerlines and Telephone Lines	Right-of-way permit	U.S. Forest Service
All Project Components	Special land use permits	Various units of local government
Conduit No. 27	Water quality certification	Colorado Department of Health
Conduit No. 27	Section 404 permit	Corps of Engineers
All Project Components	Various air pollution emission permits	Colorado Department of Health

PROPOSED ACTION

Purpose and Need

The proposed Strontia Springs Diversion Dam and Reservoir and Foothills Water Treatment Plant would be a part of the DWB South Platte River water supply system. Construction of the facilities would enable the DWB to provide treated water to the increasing population within the DWB treated-water service area and to other users at levels in keeping with current trends of consumption. Map I-5 shows the DWB's present and projected future service area.

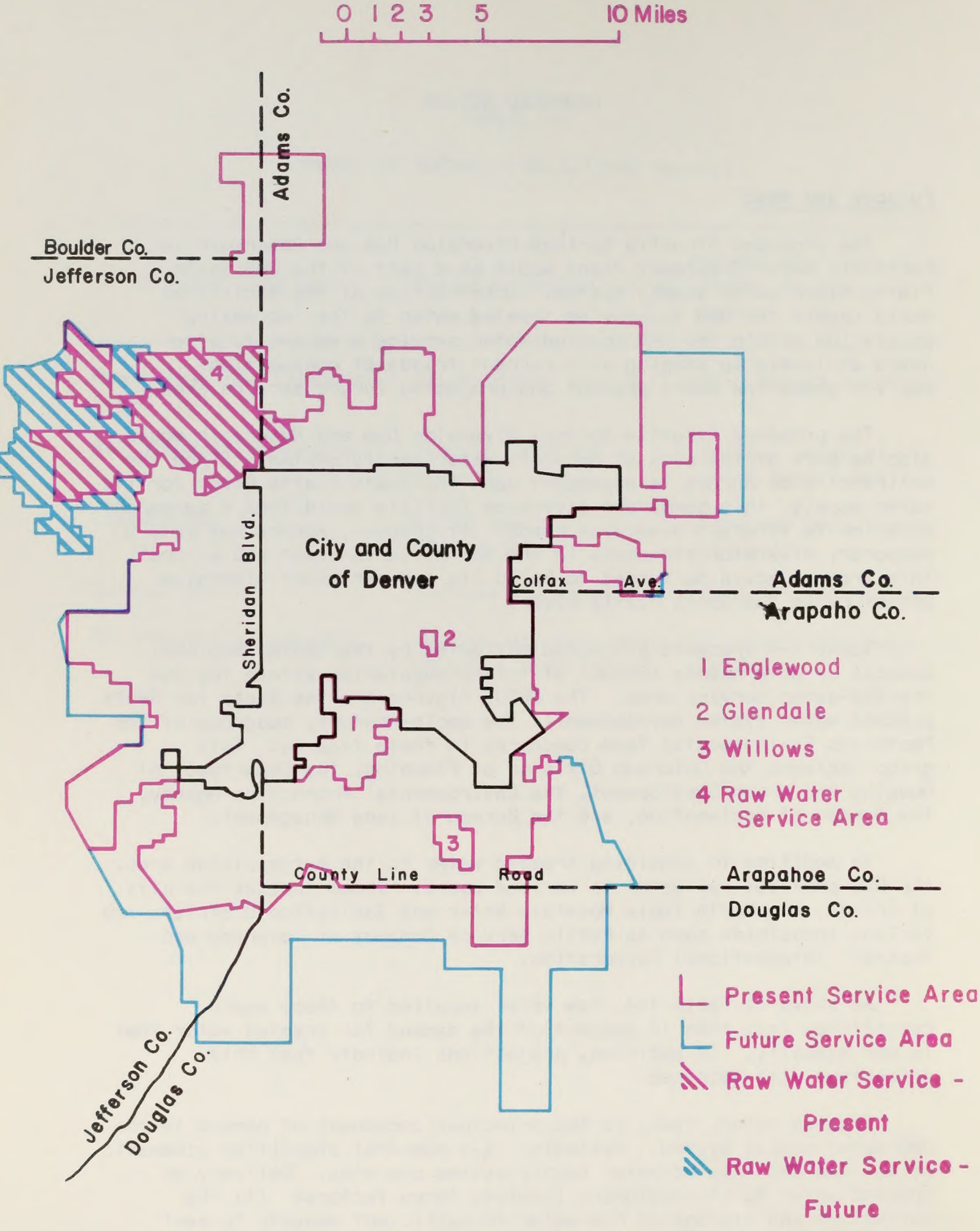
The proposed Strontia Springs Diversion Dam and Reservoir would also be part of the city of Aurora's water supply system. Since the entire city of Aurora is dependent upon the South Platte River for its water supply, this permanent diversion facility would form a permanent solution to Aurora's diversion needs. At present, Aurora has only a temporary diversion structure in the South Platte River and without this project would be forced to build its own permanent diversion structure in the South Platte River.

Table I-4 presents projected estimates by the Denver Regional Council of Governments (DRCOG) of future population within the DWB treated-water service area. The DRCOG figures are the basis for DWB's planned water system development. The socio-economic subgroup of the Foothills Environmental Team concurred in these figures. This group included the Colorado Division of Planning, the Department of Housing and Urban Development, the Environmental Protection Agency, the Bureau of Reclamation, and the Bureau of Land Management.

In addition to providing treated water to the metropolitan area, the DWB provides raw water to various users. These include the city of Arvada, the North Table Mountain Water and Sanitation District, and various industries such as Public Service Company of Colorado and Rockwell International Corporation.

As shown in Table 1-4, raw water supplied to these users constitutes less than 10 percent of the demand for treated water that is met annually. In addition, projections indicate that this percentage will decrease.

Treated water, then, is the principal component of demand in the DWB water supply system. Following is a somewhat simplified schematic of how the DWB treated-water supply system operates. Delivery of treated water to its customers involves three factors: (1) the collection and storage of raw water in sufficient amounts to meet long-term demand, (2) treatment of that raw water at a fast enough



DENVER SERVICE AREA

MAP 1-5

TABLE 1-4

SUMMARY OF DRCOG REVISED POPULATION, TREATED AND TOTAL WATER DEMANDS
DENVER WATER DEPARTMENT SERVICE AREA 1/

Year	Population	Max-Day (mgd) 5/	Per Capita Max-Day (gdc) 2/	Per Capita Annual (gdc) 2/	Annual Treated Water (acre-feet) 5/	Raw Water (acre-feet)	Total Delivered Treated And Raw Water (acre-feet) 3/
1980	958,400	589	614	226	242,977	24,922	267,899
1985	1,057,200	672	636	228	269,710	26,243	295,953
1990	1,162,900	763	656	229	298,331	26,238	324,569
2000	1,434,100	1,003	699	231	371,509	27,023	398,532
2001 4/	1,460,100	1,020	699	231	378,530	27,210	405,740
2010	1,693,700	1,257	742	233	441,719	28,962	470,681

1/ The socio-economic subgroup based its projections on two of many assumptions made by DRCOG: due to favorable perceptions and motivations the general public has regarding the Denver area, past growth patterns will continue and the area's job opportunity situation, favorable compared to the rest of the nation's, will continue.
2/ Gallons per day per capita.
3/ Column 6 plus column 7.
4/ 2001 is shown here because this is the year in which the max-day demand reaches 1,020 mgd.
5/ Data shown are derived from multiple regression techniques using independent variables of population, time, and precipitation as appropriate.

rate to meet short-term demand as it occurs, and (3) operational constraints.

The basis for long-term planning in the collection and storage of raw water is annual demand--the total volume (measured in acre-feet) of raw and treated water consumed in a given year in DWB service area. Planning involves balancing the needs of customers as reflected by annual demand against capacities for collection and storage. In wet years, a surplus of water is stored to help compensate for the lack of water available for collection in dry years. Using data on water collection extending over a period of years, it is possible to calculate the amount of water that is "reliably" available in any given year to meet annual demand in the service area. "Reliable" supply tends to be a conservative estimate of the amount of water that can be used year to year without too much risk of a gradual and ultimate depletion of the resource.

The second aspect of water supply is treatment capacity--the rate at which raw water can be treated and delivered to customers. After raw water is stored, it is selectively released into a network of man-made (e.g., conduits and tunnels) and natural (e.g., stream and rivers) conveyances to treatment plants. In the DWB system, three treatment plants act in coordination to supply the Denver service area with treated water. The combined capacities of these plants must be sufficient to meet the peak daily (max-day) demands. When the total capacity is not sufficient, a temporary shortage occurs. This shortage is caused solely by inadequate treatment capacity. There may be plenty of raw water in storage, but it cannot be treated fast enough to meet these demands. Such a situation is discussed and illustrated in Chapter 8 (Figure 8-2) in the Socio-Economic Implications section under the No Action alternative.

The third aspect of water supply includes operational constraints. Power outages affect the ability to deliver treated water. If the raw water is turbid for extended periods, the treatment plants may not be operated. Icing conditions may inhibit the ability to divert water at the intakes. The existence of any one of these conditions may diminish the ability to provide treated water on demand at critical times.

The capacity of water treatment plants is expressed in millions of gallons per day (mgd). Table 1-4 presents the projected max-day and per capita max-day demand in the DWB service area through the year 2010.

Present usable DWB treatment plant capacity is 520 mgd. As shown in Table 1-4, the total treatment capacity of 520 mgd is expected to be exceeded by 1980. Implementing the Foothills Treatment Plant at full capacity (500 mgd) would increase the total treatment capacity of the DWB to 1,020 mgd. According to projections in Table 1-5, this

capacity will be sufficient to meet max-day demand until the year 2001, when max-day demand will equal the total capacity of the DWB system. Because 2001 is the year the DWB treated-water system, with the addition of the proposed facilities, would be taxed to its limit, that year was selected as the time to measure the project's impacts.

Table 1-5 presents a projection, based on DRCOG population projections, of the number of days when the max-day demand would exceed the existing DWB collective treatment plant capacity of 520 mgd and thereby create temporary shortages.

TABLE 1-5

PROJECTION OF DAYS WHEN MAX-DAY DEMAND WOULD EXCEED TREATED WATER SUPPLY - DWB SERVICE AREA (AT EXISTING 520 mgd CAPACITY)

Year	Number of Days When Demand Exceeds Treatment Capacity	Probable Max-Day Volumes (mgd)
1980	13	589
1985	31	672
1990	40	763
2000	63	1,003
2010	73	1,257

The construction of the Strontia Springs Diversion Dam and Foothills Treatment Plant at 125 mgd would enable the DWB to use greater amounts of raw water presently available from its existing collection-storage-diversion system. With the additional 125 mgd treatment plant capacity, demands associated with the growing population within the treated-water service area could be met until around 1988. Increasing plant capacity to 500 mgd would enable the DWB to treat additional raw water, not yet developed, to meet max-day demand until about 2001.

Initially, no additional raw water supplies would need to be developed for the Foothills Project. The existing system can provide an adequate raw water supply for treatment at the existing plants (520 mgd) and the Foothills Treatment Plant at its proposed initial capacity of 125 mgd.

The present reliable annual raw water supply available to treatment plant intakes averages 298,000 acre-feet. In addition, 14,300 acre-feet of water is available to the DWB from Bear Creek and South Platte River ditch rights. These rights give the DWB a total average raw water supply of 312,300 acre-feet annually.

Reliable supply is estimated by means of simulated operation of the DWB system using the historical runoff conditions that were experienced during the 1947-1965 period. Collection and storage of runoff in the existing system was considered and the water routed through the system and delivered to the metropolitan area based on a monthly historical pattern.

The operation at capacity of the Foothills Treatment Plant at 125 mgd would create a demand for raw water on the South Platte River at the Strontia Springs Diversion Dam of approximately 195 cubic feet per second (cfs). If the Marston and Kassler Treatment Plant Intakes are also diverting water at capacity, there will be demand for a total of 595 cfs of raw water from the South Platte River. Sources from which such demand for raw water would be met are the DWB's existing South Platte and Roberts Tunnel Systems.

The proposed Foothills Project features, with one exception, are designed to accommodate expansion to a capacity of 500 mgd, in the event that population in the DWB treated-water service area grows as projected and future additional raw water supplies must be developed. The exception is distribution Conduit No. 27, which is designed to accommodate only 250 mgd.

Operation of the Foothills Treatment Plant at capacity (500 mgd) would create a demand for 773 cfs of raw water on the South Platte River at the Strontia Springs Diversion Dam. If the Marston and Kassler Treatment Plant Intakes are also diverting water at capacity, there will be demand for a total of 1,176 cfs of raw water from the South Platte River. Sources from which this year 2001 demand for raw water would be met are the DWB's existing South Platte and Roberts Tunnel Systems and potential additional sources or combinations of sources discussed in Chapter 8.

The addition of the proposed 125 and 500 mgd Foothills Treatment Plant is anticipated to change the pattern of operation of existing DWB treatment plants. Except during brief periods for maintenance, the Foothills Treatment Plant would operate at or near capacity on a year-round basis in order to take advantage of its higher elevation (5,860 feet). Figure 1-1 (at the end of this chapter) shows the relative elevations of the various DWB storage reservoirs. The higher elevation of Foothills Treatment Plant would reduce the amount of pumping required for distributing treated-water throughout the DWB treated-water service area. The Moffat, Marston, and Kassler Treatment Plants would be used primarily to supply the peak demands of

the summer and, as necessary, to augment the treated water supply required during other times of the year.

The initial 125 mgd operating capacity would increase the total DWB treatment capacity to 645 mgd. Increasing the Foothills plant to 500 mgd would provide a total of 1,020 mgd treatment capacity.

Construction of the Foothills Project would provide for an electric power savings over the present operational system. This power savings at the 125 mgd development level would be 16 million kilowatt-hours and at the 500 mgd development level would be 63.9 million kilowatt-hours.

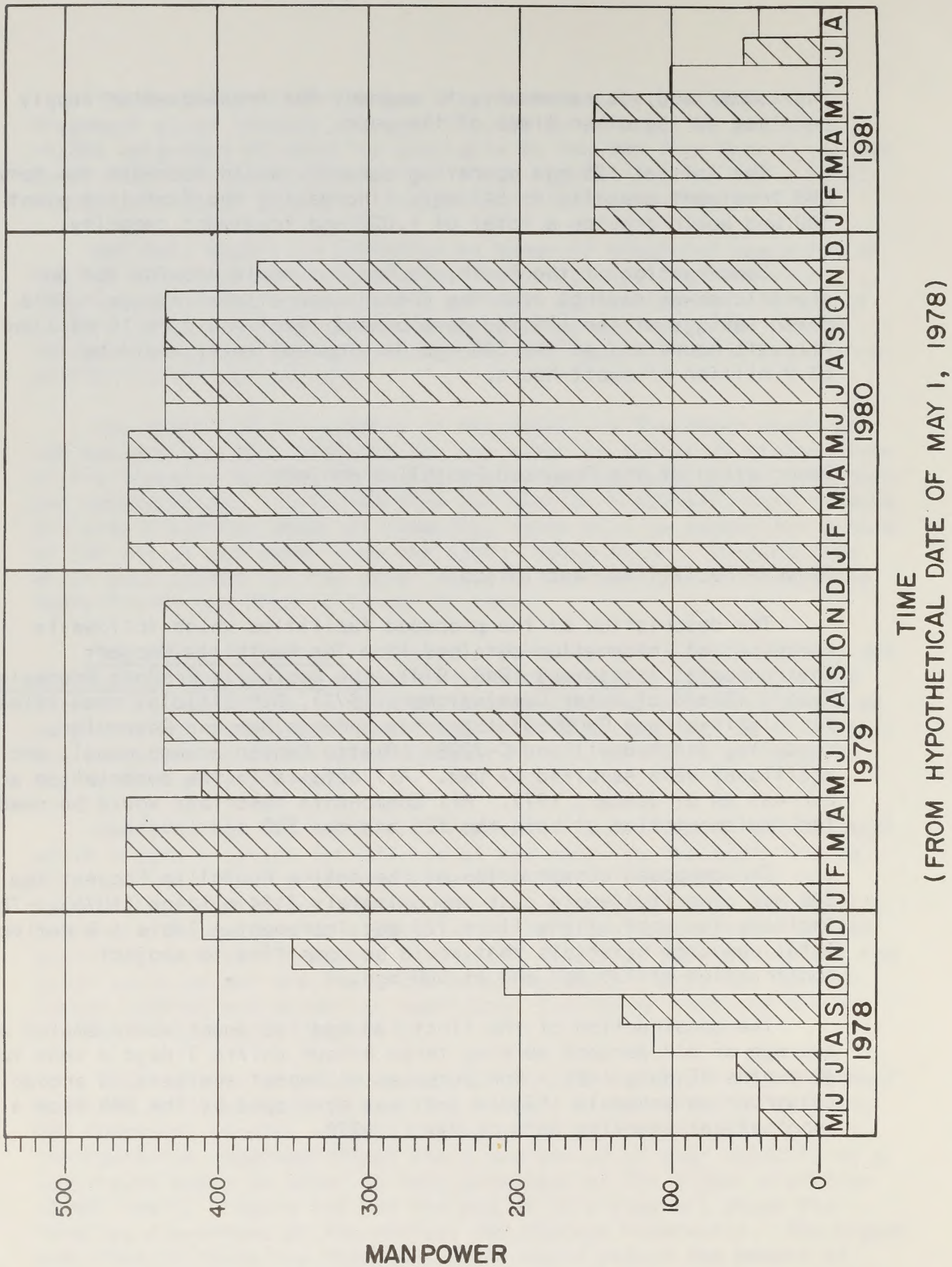
Description of the Proposed Foothills Project

General Facilities Description

The description of the proposed facilities which follows is comprised of information obtained from The Foothills Project Environmental Assessment (DWB 1974), The Foothills Project Predesign Report (Board of Water Commissioners 1973), BLM official case files for rights-of-way C-099597 (Strontia Springs Dam and Reservior, conduits, and tunnel) and C-22081 (Platte Canyon access road), and additional data supplied by DWB. All details in the description are current as of January 1977. All components described would be needed for implementation at both the 125 and the 500 mgd levels.

The proposed construction of the entire Foothills Project (up to 500 mgd capacity) would cost approximately $134 million (1976). This includes the cost of the first 125 mgd increment. Table 1-6 reflects total resource materials that would be committed to project construction at 125 mgd and at 500 mgd.

The construction of the first 125 mgd increment would employ an average of 317 persons working three 8-hour shifts 7 days a week for 40 months (Figure 1-2). For purposes of impact analysis, a probable construction schedule (Figure 1-3) was developed by the DWB from a hypothetical starting date of May 1, 1978.



ESTIMATED MANPOWER REQUIREMENTS
PROPOSED FOOTHILLS PROJECT
AT 125 MGD.

FIGURE 1-2

PROPOSED FOOTHILLS PROJECT
HYPOTHETICAL CONSTRUCTION SCHEDULE

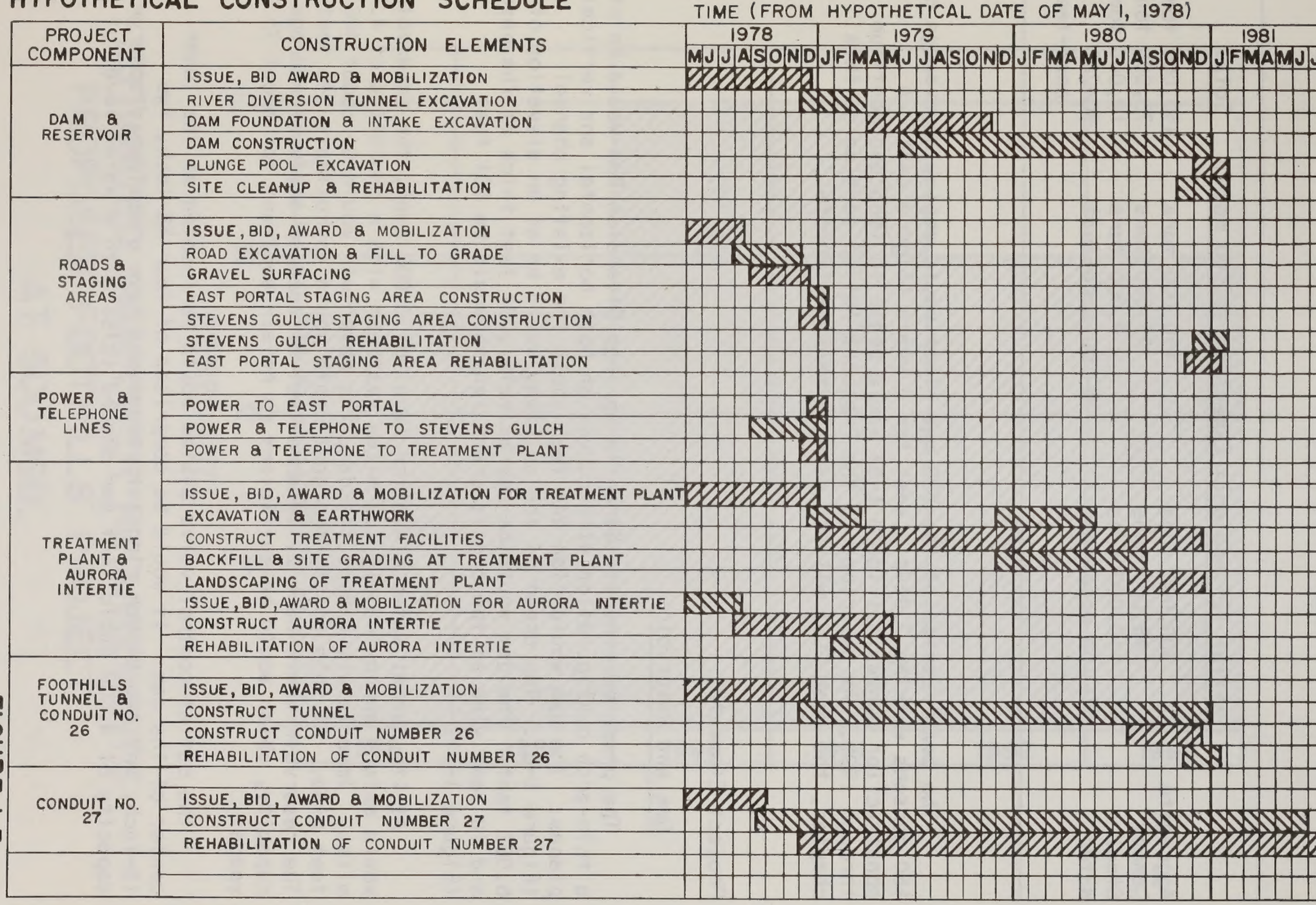


FIGURE 1-3

TABLE 1-6

SUMMARY OF PROJECT MATERIALS

	Initial 125 mgd unit	Expansion to 500 mgd	Total
Aggregate	300,000 tons	150,000 tons	450,000 tons
Cement	48,000 tons	25,000 tons	73,000 tons
Steel	10,000 tons	9,000 tons	19,000 tons
Water	90-100 acre-feet	90-100 acre-feet	180-200 acre-feet

The construction of the 500 mgd plant would employ an average of 160 persons working 7 days a week for 6 years (Figure 1-4). A construction schedule (Figure 1-5) would begin in 1986 and continue through 1998. As described in the Proposed Action section of this chapter, the year 2001 will be used to measure impacts.

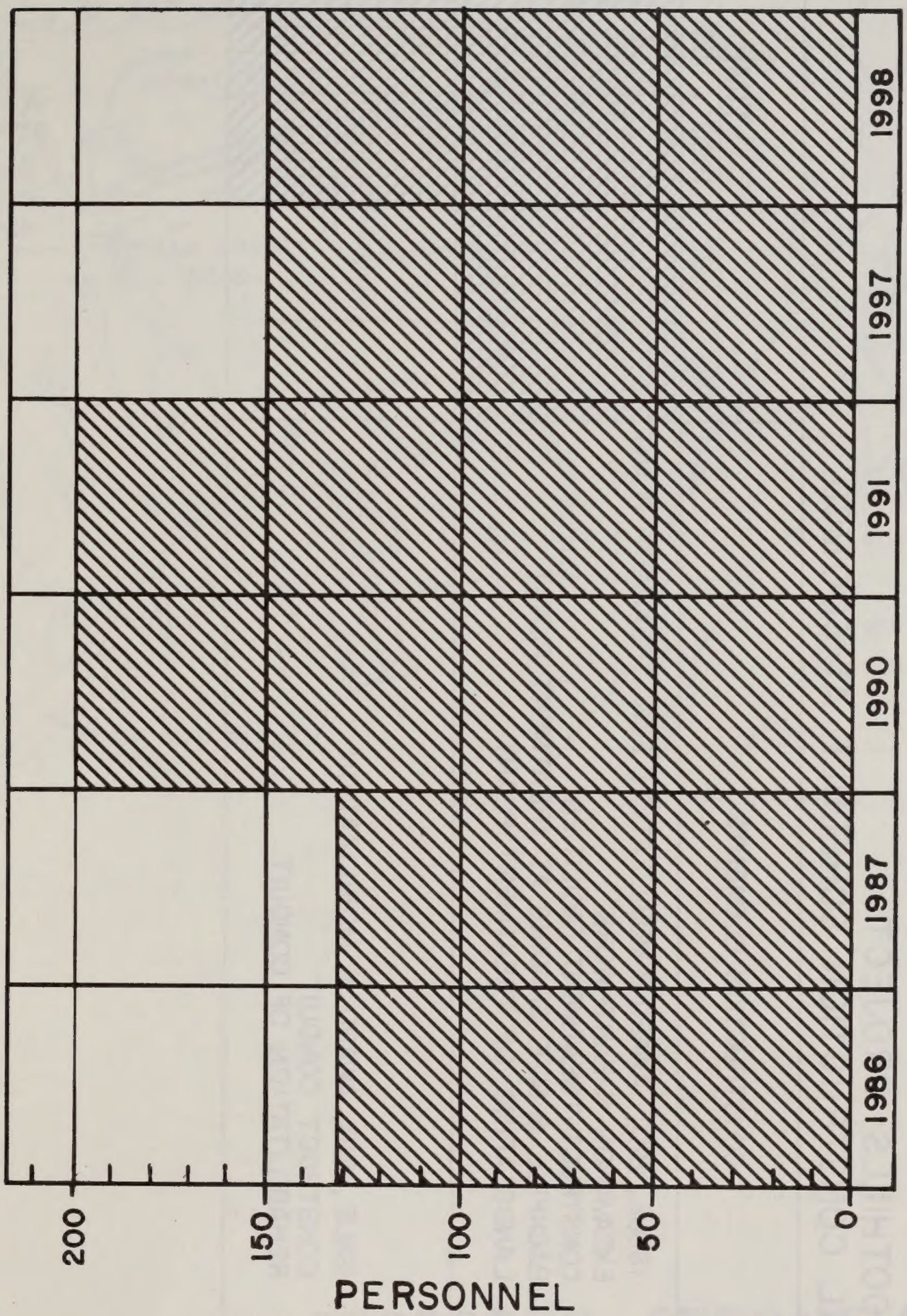
Project Elements

Dam and Reservoir

The proposed concrete Strontia Springs Diversion Dam would be of a thin-arch configuration with curves on both horizontal and vertical planes. The dam would rise 243 feet above the existing channel (Figure 1-6). The crest of the spillway would be at an elevation of 6,002 feet. The dam would be approximately 31 feet thick at the base and 10 feet wide at the crest; crest length would be 601 feet (Figure 1-7).

At its normal water elevation level of 6,002 feet, the reservoir would extend approximately 1.7 miles upstream with a shoreline of 4.9 miles. Immediately behind the dam, the reservoir would be about 400 feet wide. At this point, the pool depth would approximate 240 feet. The reservoir would have 2,110 acre-feet of dead or sediment storage capacity, which would be sufficient to retain sediment for about 75 years.

The outlet-control valve system would be located at the lower center of the dam. It would be comprised of four 48-inch, two 18-inch, and two 8-inch ring jet valves and have a maximum discharge capacity of 4,000 cubic feet per second (cfs) with a water level of



ESTIMATED MANPOWER REQUIREMENTS
PROPOSED FOOTHILLS PROJECT
AT 500 MGD.

FIGURE I-4

PROPOSED FOOTHILLS PROJECT
HYPOTHETICAL CONSTRUCTION SCHEDULE AT 500 MGD.

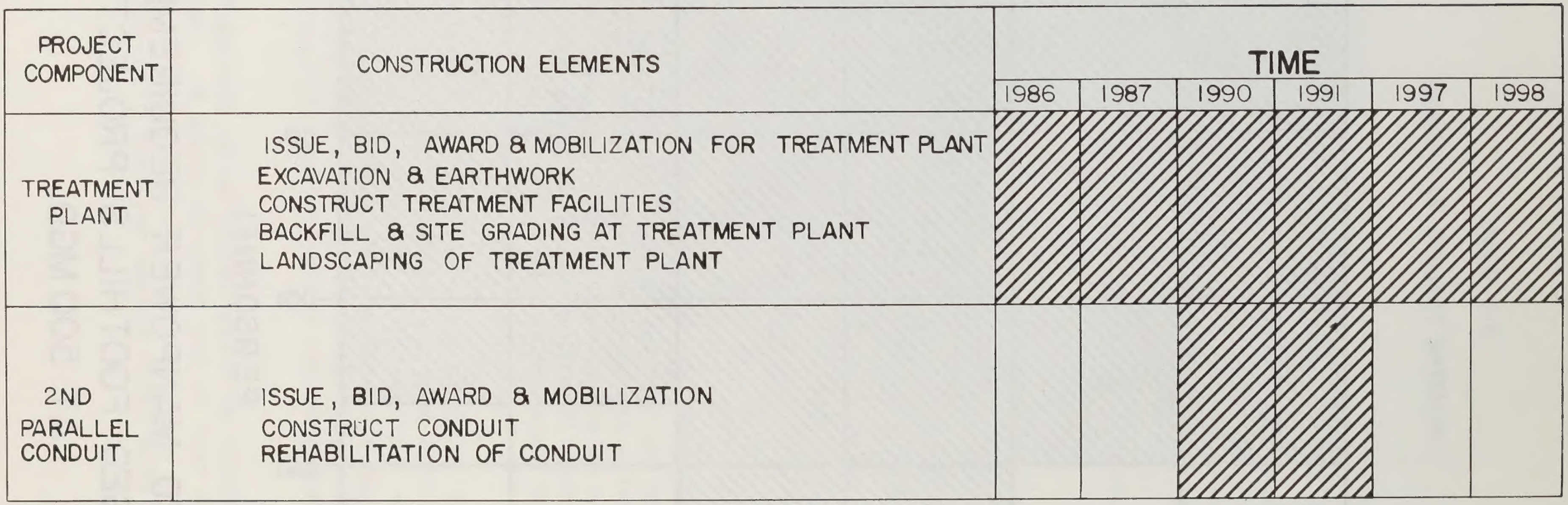
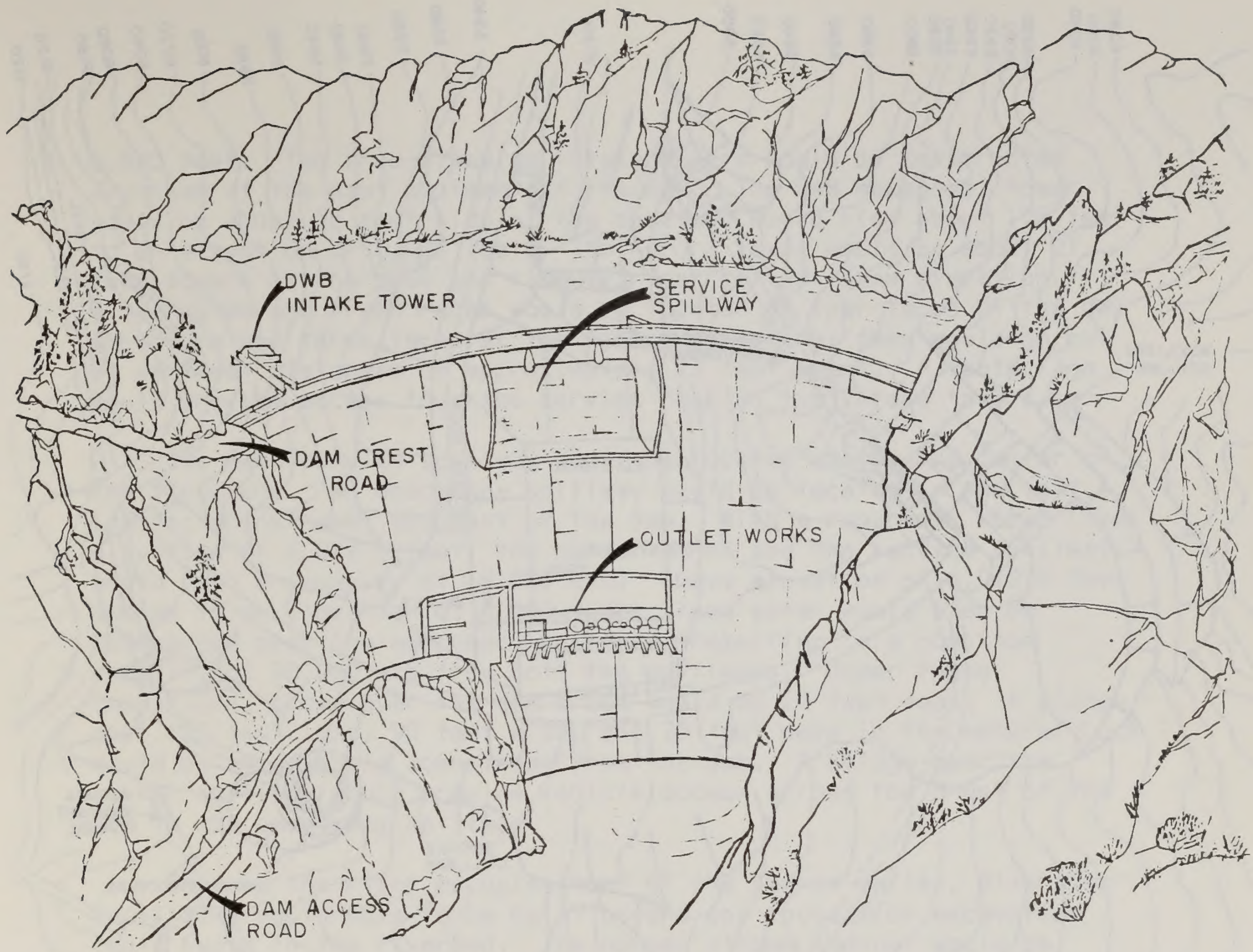


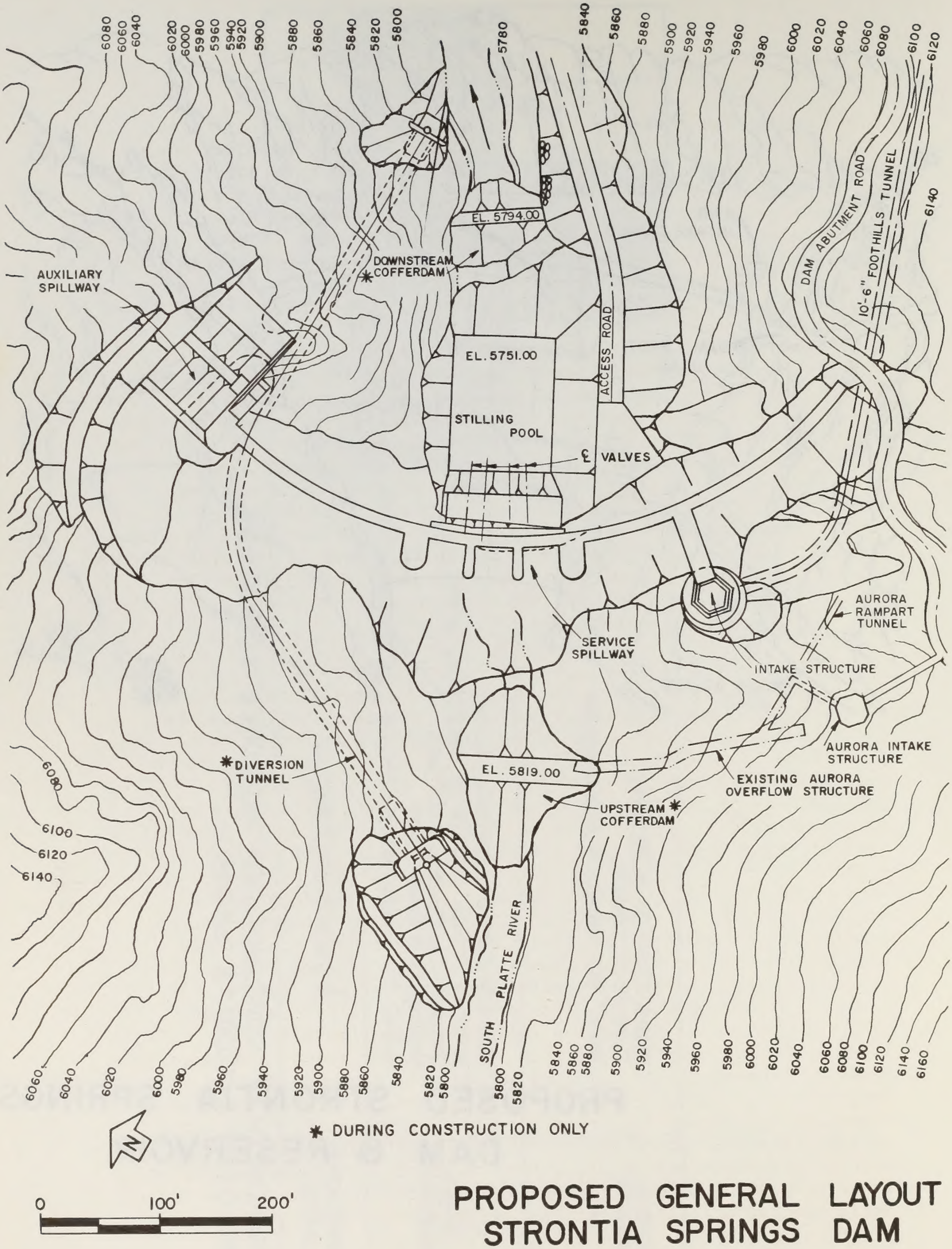
FIGURE I-5



PROPOSED STRONTIA SPRINGS DAM & RESERVOIR

FIGURE I-6

PREPARED BY FOOTHILLS PROJECT CONSULTANTS



PROPOSED GENERAL LAYOUT STRONTIA SPRINGS DAM

FIGURE I-7

PREPARED BY FOOTHILLS PROJECT CONSULTANTS

6,002 feet. Two free-standing intake towers would be constructed upstream of the east abutment of the dam. The DWB hexagonal tower would be about 35 feet wide at the base and would rise about 179 feet to an elevation of 6,029 feet. The Aurora tower would be about 21 feet square at the base and rise 123 feet to that same elevation. Slide gates and trash racks would be located on four faces of the DWB structure and three faces of the Aurora structure; they would be set at vertical distances of approximately 23 feet apart. A footbridge would provide access from the service road to the intake towers.

The main service spillway would be located at the top center of the structure. An emergency spillway would be located in the left (facing downstream) abutment of the dam. With a reservoir water level elevation of 6,012.5 feet, the outlet works and the service spillway would have a capacity of 16,000 cfs. Above elevation of 6,012.5 feet and up to an elevation of 6,029 feet, flood water would also be discharged over the emergency spillway, resulting in a combined capacity of 90,000 cfs from both the spillways. Under these conditions, flows over the dam crest would be 27 feet deep. A plunge pool 120 feet long, 90 feet wide, and 25 feet deep in the natural rock would be immediately downstream from the dam. A bridge over the center spillway would provide vehicle access across the crest of the dam to the emergency spillway.

Because the river occupies most of the narrow valley, diversion facilities would have to be built before any foundation excavation could begin in the riverbed. The normal stream channel would be diverted through a temporary system involving a diversion tunnel and cofferdams (Figure 1-7). The tunnel and diversion system would be designed to withstand 25-year flood flows and pass 4,440 cfs. Construction of the tunnel, 18 feet in diameter, would begin at approximately 250 feet upstream of the axis of the dam at a portal in the left river bank and continue downstream about 700 feet to a point approximately 350 feet below the dam. The upstream portal would house a bulkhead gate for temporary tunnel closure. A 38-foot concrete plug would be poured in the tunnel at the dam axis for permanent tunnel closure after construction. One cofferdam would be constructed upstream of the dam site to divert the river into and through the diversion tunnel. Above the point where the stream flow returns to the established channel, another dam would be built downstream. Construction of the cofferdams would use approximately 6,700 cubic yards of spoil (mostly rock) from the diversion tunnel and impervious material from an existing 1 acre borrow area near the Kassler Treatment Plant (Map 1-2). The faces of the cofferdams would be riprapped to protect them from erosion. The estimated 1,500 cubic yards of material contained in the lower cofferdam would be completely removed and deposited in Stevens Gulch to reduce stream sedimentation after completion of construction. Construction of the bypass tunnel would involve drilling, blasting, and removing tunnel muck. About

1 acre would be available as a staging area for construction between the two cofferdams.

After completion of diversion facilities, dewatering of the stream channel and excavation in the riverbed would begin. Any fish encountered in this process would be removed and placed upstream above the cofferdams. After construction of the dam, the plunge pool would be excavated. From the excavation, spoil material estimated at 130,000 cubic yards would be disposed of by filling side gulches below the elevation of 5,935 feet in the reservoir area. Metal culverts would be placed under the fill to drain the side gulches into the river to minimize erosion. Overflow weirs would also be provided. The excavation would cause cuts into the rock, approximately 60 feet deep into the valley floor and 35 feet into the left and right abutments. The DWB expects there would be some seepage of water as a result of this excavation and proposes that the contractor assume responsibility for pollution abatement measures. The DWB would secure the necessary stream-discharge permits from the Colorado Department of Health. It is expected that high turbidity would occur for a short period of time during the actual diversion of the river. Blasting would occur throughout the excavation operation about twice a day on a regular schedule.

The excavation for the dam abutments would not affect the operation of Aurora's facilities near the dam site except that precautions would be required during excavation above Aurora's existing structures. Aurora's water service should not be interrupted except in the case of an accident or for a short period when excavation is completed between the Aurora Intake Tower and Tunnel No. 1. The existing Aurora intake and conduit upstream would be abandoned in place and would eventually be inundated by the proposed reservoir.

Although a variety of methods exist for handling concrete operations, the one which most probably would be used is summarized in the following paragraphs.

The DWB has identified sources of aggregate in the South Platte River Valley about 1 mile downstream from Kassler (Map 1-3). This aggregate would be used in making concrete. Specifically, the aggregate would be mined within the Chatfield Reservoir area from the zone lying between the perimeter of the static pool and the highwater line. The gravel would be washed and screened at the gravel source and hauled 8 miles to the concrete batching area which would probably be located in Stevens Gulch. About 109,000 cubic yards would be hauled from this source over the Platte Canyon Road. Since there is not sufficient area for aggregate storage at the Stevens Gulch staging area, it is probable that hauling would be necessary throughout the 17-month dam construction period, averaging about 20 truckloads per day (assuming use of trucks with a capacity of 10 cubic yards).

The DWB has contacted local suppliers of aggregate. Among suppliers contacted was Peter Kiewit who plans to be in the Chatfield site until 1991. If this site is not sufficient to meet construction needs, there are other sources immediately downstream of the dam on the north side of Interstate Highway 470. The DWB has been advised that obtaining aggregate in any size and quantity will pose no problem. The Chatfield aggregate was sampled and analyzed and found to be of a quality that would meet the specifications for Foothills.

The mixed concrete would probably be transferred to hoisting-placing equipment at the valley floor. To support this equipment, two 4-foot-thick concrete foundation blocks would be placed on the natural rock floor of the canyon. These blocks would be incorporated into the dam structure or removed after use. Cableways or tower cranes would move the concrete.

Approximately 117 acres of vegetation in the reservoir would be cleared in the area of the maximum pool to the 6,029-foot elevation. Marketable timber would be cut and removed from the canyon; other logs would be cut and used as firewood. The remainder would be chipped and disposed of as mulch in disturbed areas above the high-water line (6,029-foot elevation).

Upon completion of the project, releases of stored water and the flows through the rivers to the Foothills system would be a function of water demands made by the customers of the city and county of Denver. Water released from Dillon Reservoir would flow through the Roberts Tunnel into the North Fork of the South Platte River. A stream gage near Stevens Gulch would be used to measure flows in the South Platte River below the Strontia Springs Dam.

Raw water from the reservoir would enter the Foothills Tunnel and the Aurora Tunnel system (existing) via the gates on the intake towers. During periods of operations at the 125-mgd rate, water turnover at the reservoir would occur every 20 days; at 500 mgd, turnover would approximate 5 days. This would also be the length of the silt-settling period. Fluctuation would be very slight because the pool normally is relatively stable at 6,002 feet of elevation.

The caretaker, who lives immediately downstream from the existing Platte Canyon Intake, would operate these gates as well as those on the outlet works. The dam facility would be lighted to accommodate night operation.

Access Roads and Staging Areas

Access roads and staging areas are proposed to support the construction operation (Map 1-2). During construction, the existing

access road in the South Platte Canyon would be closed to all uses not related to the construction effort. The existing road from the Platte Canyon Intake to Stevens Gulch, about 13,950 feet in length, would be improved to accommodate construction traffic. The road would have a 2 to 3 percent grade and a general roadway of 22 feet over a distance of about 13,900 feet. Typical road cross-sections are shown in Figure 1-8.

Only one crossing of the South Platte River at the location of the existing narrow gage railroad bridge would be necessary. That structure would be replaced by a steel beamed-concrete deck bridge with a 22-foot running surface employing the existing abutments. Plans call for the Keystone Bridge to be carefully dismantled, piece-marked, and stored at Kassler for future use as appropriate.

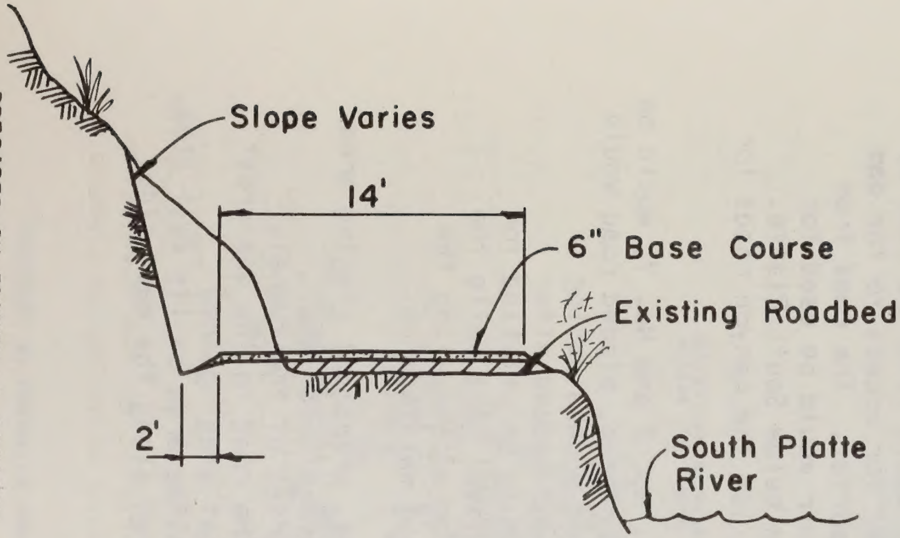
Except at Mill Gulch and Stevens Gulch, culverts would be installed at all drainage crossings where paved waterway sections would be placed. These sections would be located over culverts to allow passage of normal runoff. Additional fill material would be added to the existing roadway in the canyon, raising the roadbed a maximum of 5 feet. This would reduce possible damage from flooding. The design of the canyon road as proposed does not recognize any road cuts or fills that are not absolutely necessary. However, some cuts and fills cannot be avoided. These areas are estimated at less than 5 acres; in these areas, the DWB proposes to place topsoil on the fills and plant them with appropriate ground cover. The widening would require about 5 additional acres for the roadbed.

At Stevens Gulch the road would fork. The left fork would have a 22-foot roadway and would extend up and beyond Stevens Gulch 5,000 feet to the right abutment of the dam crest. This road would switch back about 2,000 feet up the gulch and contour back for another 3,000 feet at a grade of nearly 10 percent. That last 3,000 feet would require the only new road construction in the Platte Canyon. It would permanently displace approximately 2 acres and disturb an additional 2 acres.

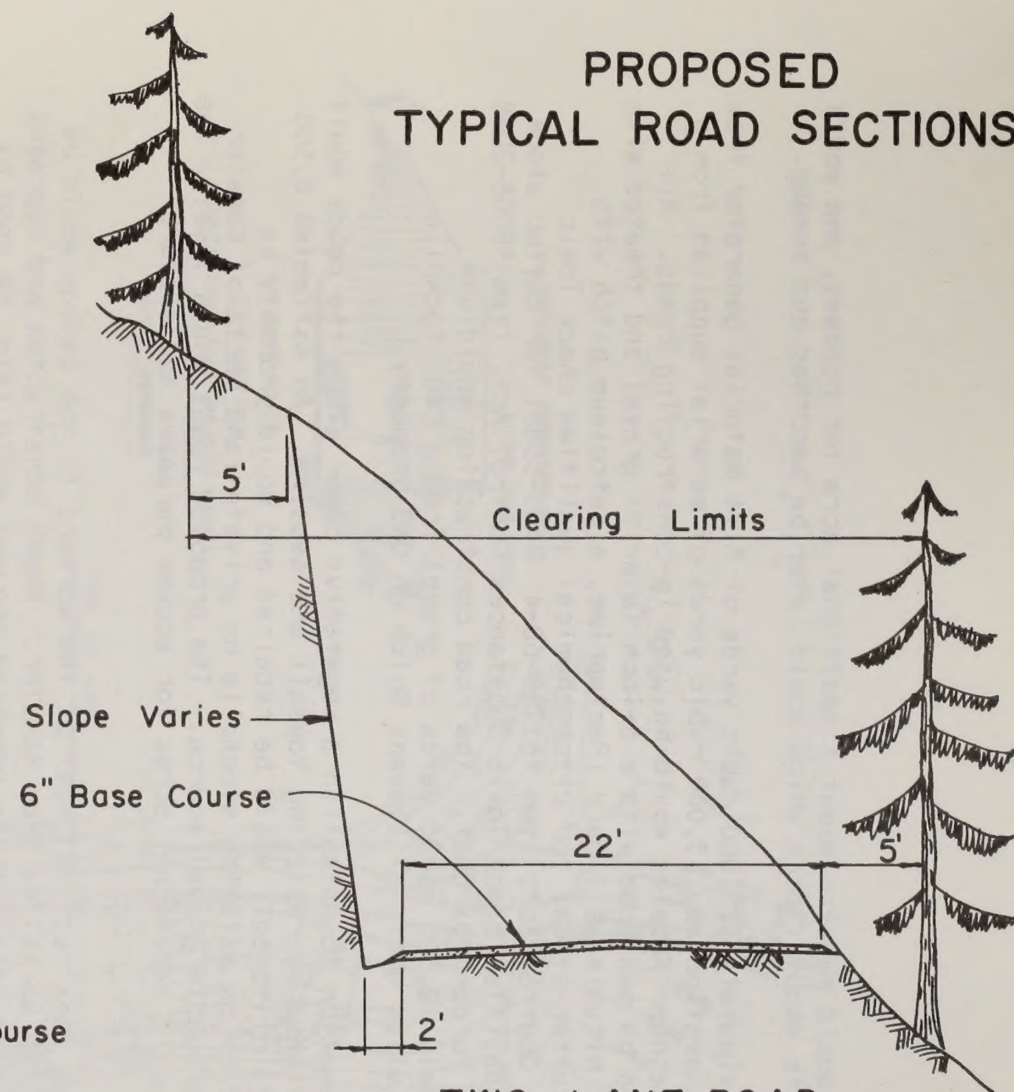
The right fork from Stevens Gulch would have a 22-foot roadway and would follow the existing road along the river to the base of the dam site--a distance of about 1,500 feet. About 1 acre would be devoted to road widening. Rehabilitation would not be practical.

The existing road, which would be located in the dam and reservoir area and would later be inundated, would be maintained with only minimum upgrading. The existing road upstream from the proposed reservoir would be improved to provide a 13-foot roadway with turnouts over a distance of 6,400 feet from the upstream end of the reservoir to the town of South Platte. This road would be used to transport some of the workers to the site to reduce traffic on the downstream road. This proposed improvement would involve widening only where

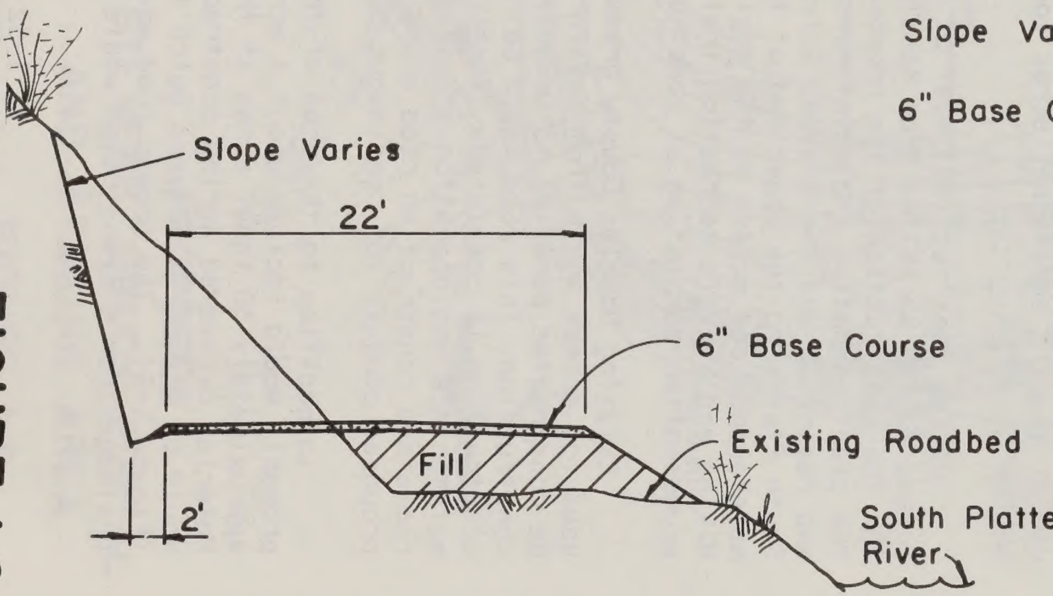
PROPOSED TYPICAL ROAD SECTIONS



SINGLE-LANE ROAD
SOUTH PLATTE CANYON



TWO-LANE ROAD
DAM ABUTMENT ROAD



TWO-LANE ROAD
SOUTH PLATTE CANYON

FIGURE I-8

possible, would require about 1 additional acre for roadway, and would also disturb about 1 acre which would later be smoothed and seeded.

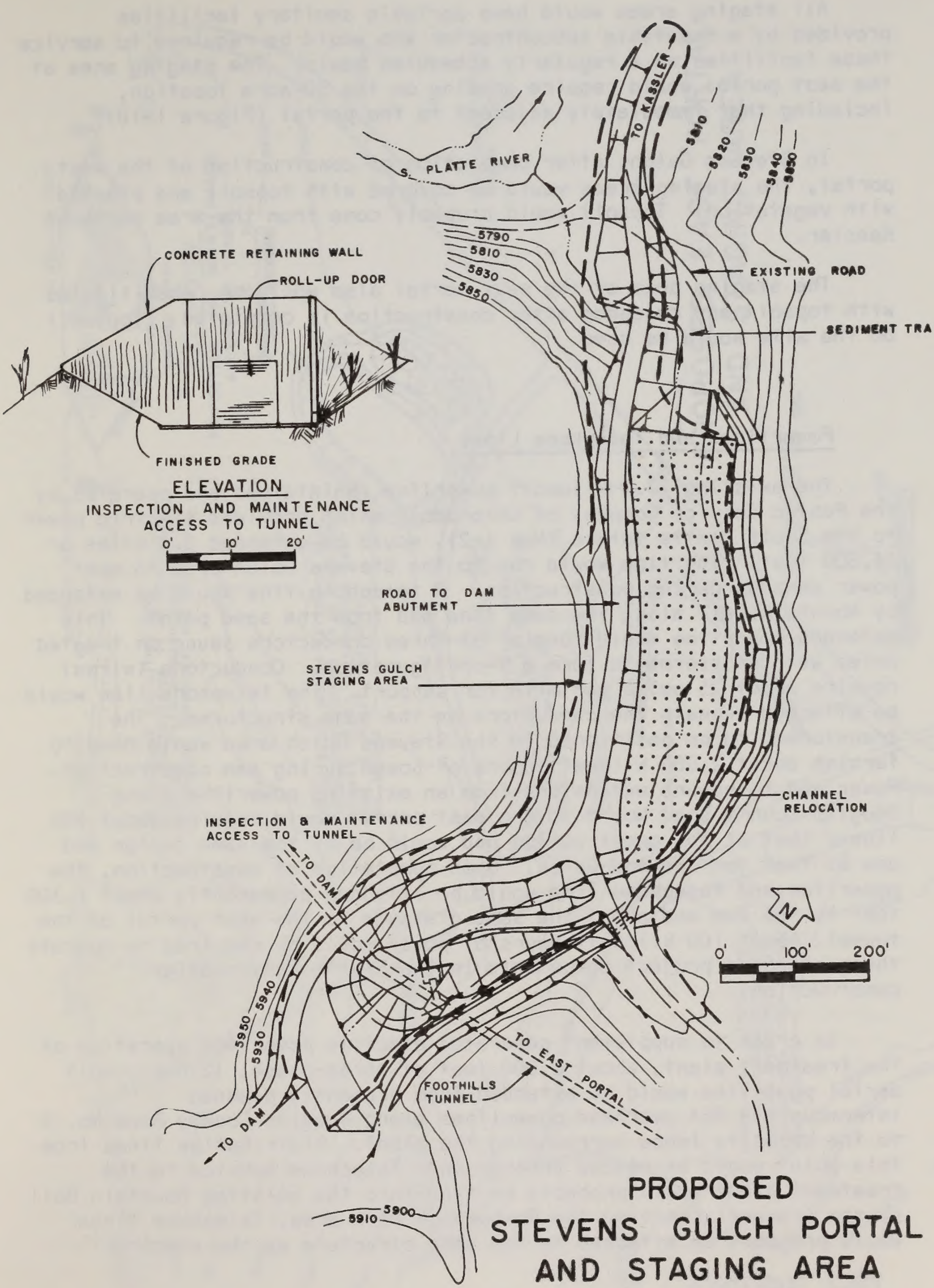
Approximately 125,000 cubic yards of fill material generated from roadway excavation and 15,000 cubic yards of material supplied from a borrow area near Kassler would be used in constructing roads. All roads would be surfaced with a 6-inch layer of gravel and treated with a nontoxic bituminous liquid (Pentaprime, a petroleum pitch with kerosene cutter stock; for pitch chemical qualities check Toxic Substances Control Act, Item *61789-60-4 B405-5588; for cutter stock chemical qualities check Toxic Substances Control Act, Item *8008-20-6 B032-5147) to control dust. The road construction would use approximately 12,500 cubic yards of gravel from a DWB stockpile located 3 miles north of Stevens Gulch on DWB property.

Reclamation to establish a vegetative cover along the roads would be accomplished by replacing topsoil and seeding. An estimated 6,500 cubic yards of topsoil would be required and would probably be obtained from an existing stockpile on private land north of Kassler near the probable gravel source. The proposed roads would involve the use of about 9 additional acres for access purposes and disturb another 8 acres.

During construction, most of the workers in the canyon would be bussed to the worksites from Kassler. Roads constructed and upgraded for the construction of the proposed project would later be used by the plant operation and maintenance personnel for access to the dam and reservoir and the Stevens Gulch common portal. The road from South Platte to the upper end of the reservoir would be used for maintenance and access to the gaging station below South Platte. Hiking and bicycle recreation traffic would use the canyon roads for access after completion of construction.

Existing Douglas County graveled roads, No. 5 and No. 7, would be used for access south from Kassler. An unsurfaced, bladed road would be constructed parallel to Conduit No. 27 for access during construction. This road would be reclaimed and seeded after construction is completed. Existing roads would be utilized for maintenance and operation access to the proposed line while the reclaimed construction road would be used for access along the proposed conduit for continuous operation and maintenance.

In addition to the area at the dam site, principal staging areas probably would include about 4 acres in Stevens Gulch and approximately 30 level acres at the east portal of the tunnel. Material excavated during construction of the road to the dam crest would be placed in Stevens Gulch to form that staging area (Figure 1-9). The access road would bypass the area on its west side. Drainage from Stevens Gulch would be rerouted along the east side.



PROPOSED
STEVENS GULCH PORTAL
AND STAGING AREA

FIGURE I-9

All staging areas would have portable sanitary facilities provided by a reputable subcontractor who would be required to service these facilities on a regularly scheduled basis. The staging area at the east portal would require grading on the 30-acre location, including that immediately adjacent to the portal (Figure 1-10).

In Stevens Gulch, after completion of construction of the west portal, the staging areas would be covered with topsoil and planted with vegetation. Topsoil would probably come from the area north of Kassler.

The staging area at the east portal also would be rehabilitated with topsoil and reseeded after construction is completed. Top soil on the site would be used.

Powerlines and Telephone Lines

The existing 13.2-kilovolt powerline (maintained and operated by the Public Service Company of Colorado), which provides electric power to the South Platte Intake (Map 1-2), would be extended 2.8 miles or 14,800 feet. The line would run to the Stevens Gulch area to meet power demands during construction. A telephone line would be extended by Mountain Bell along the same line and from the same point. This extended powerline would consist of three conductors swung on treated poles with crossarms to form a T-configuration. Conductors (wires) require about 25 poles per mile for support. The telephone line would be attached beneath the conductors on the same structures. The transformer to be positioned in the Stevens Gulch area would need to furnish about 2,000 kilowatt-hours of power during dam construction. Power and telephone extensions from an existing powerline along Douglas County Road No. 5 to the east portal would require about 500 linear feet of new construction and would be of the same design and use as that for Stevens Gulch. Upon completion of construction, the powerline and telephone line would be extended permanently about 1,300 feet to the dam and about the same distance to the west portal of the tunnel. About 100 kilowatt-hours of power would be required to operate these proposed project components in the Platte Canyon after construction.

In order to supplement generated electric power for operation of the treatment plant, about 2,000 feet of three-phase, 12.6-kilovolt aerial powerline would be extended from presently planned Intermountain REA overhead powerlines along Douglas County Road No. 5 to the security fence surrounding the plant. Distribution lines from this point would be placed underground. Telephone service to the treatment plant would probably be tied into the existing Mountain Bell system presently serving the Roxborough Park area. Telephone lines would probably be attached to the same structure as the electric

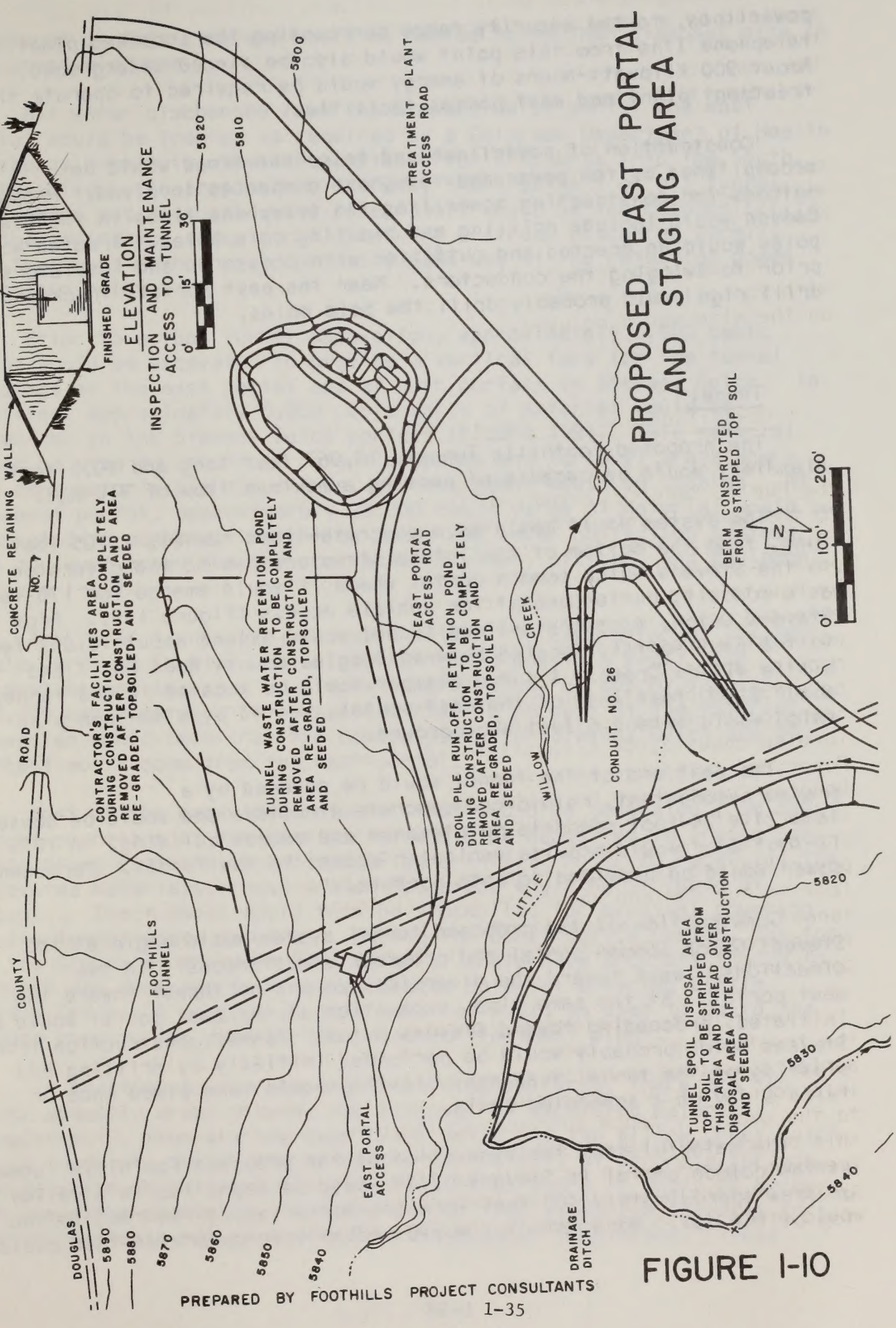


FIGURE I-10

PREPARED BY FOOTHILLS PROJECT CONSULTANTS

powerlines, to the security fence surrounding the proposed plant. The telephone line from this point would also be placed underground. About 900 kilowatt-hours of energy would be required to operate the treatment plant and west portal facilities.

Construction of powerlines and telephone lines would be accomplished by the power and telephone companies involved. Probable methods for constructing powerlines and telephone lines in the Platte Canyon would include drilling and blasting pole holes. Treated wooden poles would be erected and outfitted with crossarms and insulators prior to swinging the conductors. Near the east portal, truck-mounted drill rigs would probably drill the pole holes.

Tunnel

The proposed Foothills Tunnel, 17,967 feet long and 10.5 feet in diameter, would be capable of passing a maximum flow of 710 mgd.

The system would begin as a concrete-lined tunnel, 1,705 feet long, from the bottom of the intake structure behind the diversion dam to the Stevens Gulch common portal where it would emerge for 170 feet as a conduit, buried except for vehicle access (Figure 1-9). From Stevens Gulch, a concrete-lined tunnel would extend about 16,092 feet to the east portal, located between Douglas County Road No. 7 and Little Willow Creek. A surge chamber would be located in the tunnel about 2,900 feet west of the east portal, vented by a 48-inch pipe which would extend 6 feet aboveground.

The east end of the tunnel would be covered by a pressure-competent, reinforced concrete structure and would be housed in a 24 x 24-foot concrete maintenance and access building. A 10 x 12-foot door would provide vehicular access to the tunnel. Permanent power would be provided to both portals.

Construction of the proposed tunnel system would begin at the Stevens Gulch common portal and progress simultaneously in two directions: west toward the diversion dam and northeast toward the east portal. At the same time, excavation at the east portal would be initiated, proceeding toward Stevens Gulch. Tunnel construction from Stevens Gulch probably would be performed initially by drilling and blasting of the tunnel headings. Blasting would take place once or twice a day on a scheduled basis.

The material from the excavation of the proposed Foothills Tunnel at the common portal in Stevens Gulch would be deposited in a valley or draw approximately 400 feet from the portal along the road to the top of the dam. More material would probably be generated than could

be stored at this site and would be hauled to another disposal site in the reservoir area.

All water discharged from the Stevens Gulch portal and east portal would be treated as required by a Colorado Department of Health discharge permit to make it acceptable for discharge into the South Platte River. As proposed by the DWB, the treatment of all tunnel wastewater and disposal waste pile runoff would be the responsibility of the contractor after first obtaining a stream discharge permit. The treatment method would probably make use of the retention ponds described below.

Prior to actual tunnel excavation, approximately 3,000 cubic yards would be excavated to provide a vertical face for the tunnel headings at the east portal and at both portals in Stevens Gulch. In addition, approximately 5,000 cubic yards of material would be excavated in the Stevens Gulch portals (Figure 1-9). This material would be used to construct retention ponds and to level areas where the contractor's plant, offices, and equipment would be located. At the east portal, approximately 28,000 cubic yards of material would be excavated to construct retention ponds and water collection systems and to level areas for the contractor's plant, offices, and equipment (Figure 1-10).

The total tunnel project would entail the excavation of 102,000 cubic yards of in-place material that could possibly swell upon excavation and increase to a total waste volume of approximately 143,000 cubic yards. It is assumed that 40 percent of the material generated would come from the common portal at Stevens Gulch and 60 percent would come from the east portal.

Most of the excavated material that would be generated from the tunnel operation at the east portal would be deposited in prescribed areas along Little Willow Creek (Figure 1-10). Prior to receiving the excavated materials, these prescribed areas would be stripped of topsoil. The topsoil would then be stockpiled for eventual covering of the tunnel waste material. During the construction period, the toe of the slopes of the deposited material would have a cutoff trench to prevent any drainage from the excavated material entering Little Willow Creek. A portion of this material would be used to build the access road to the site of the proposed treatment plant.

In addition to the Stevens Gulch disposal area, there are two other specific areas planned for disposal of excavated material. Specifically, they are the Bear Creek Gulch and the Willow Creek Gulch which feed into the Platte River in the vicinity of Strontia Springs. The material would be dumped at an elevation where it would be below the low water operating level and out of the respective channels to prevent siltation and erosion prior to project completion. These

areas would be accessible via the abutment road and would provide an ideal disposal area if it were needed.

Tunnel construction initiated from the east portal would also require drilling and blasting.

After excavation, the tunnels would be lined with steel reinforcement and conventionally- placed concrete averaging 8 inches in thickness. Concrete batch plants would be needed at either or both portal staging areas.

After construction, the structure in Stevens Gulch would be back filled, covered with topsoil, and seeded. The completed structure at the east portal would be shaped to original contour with material from the staging area excavation. The area would be landscaped and seeded.

After completion of the proposed Foothills Project, water would enter the tunnel at its western terminus directly below the intake structure behind Strontia Springs Dam. Selective drawoff from the reservoir would be made possible by the slide gates at various elevations on the intake tower. Trash racks would prevent large objects from entering the tunnel.

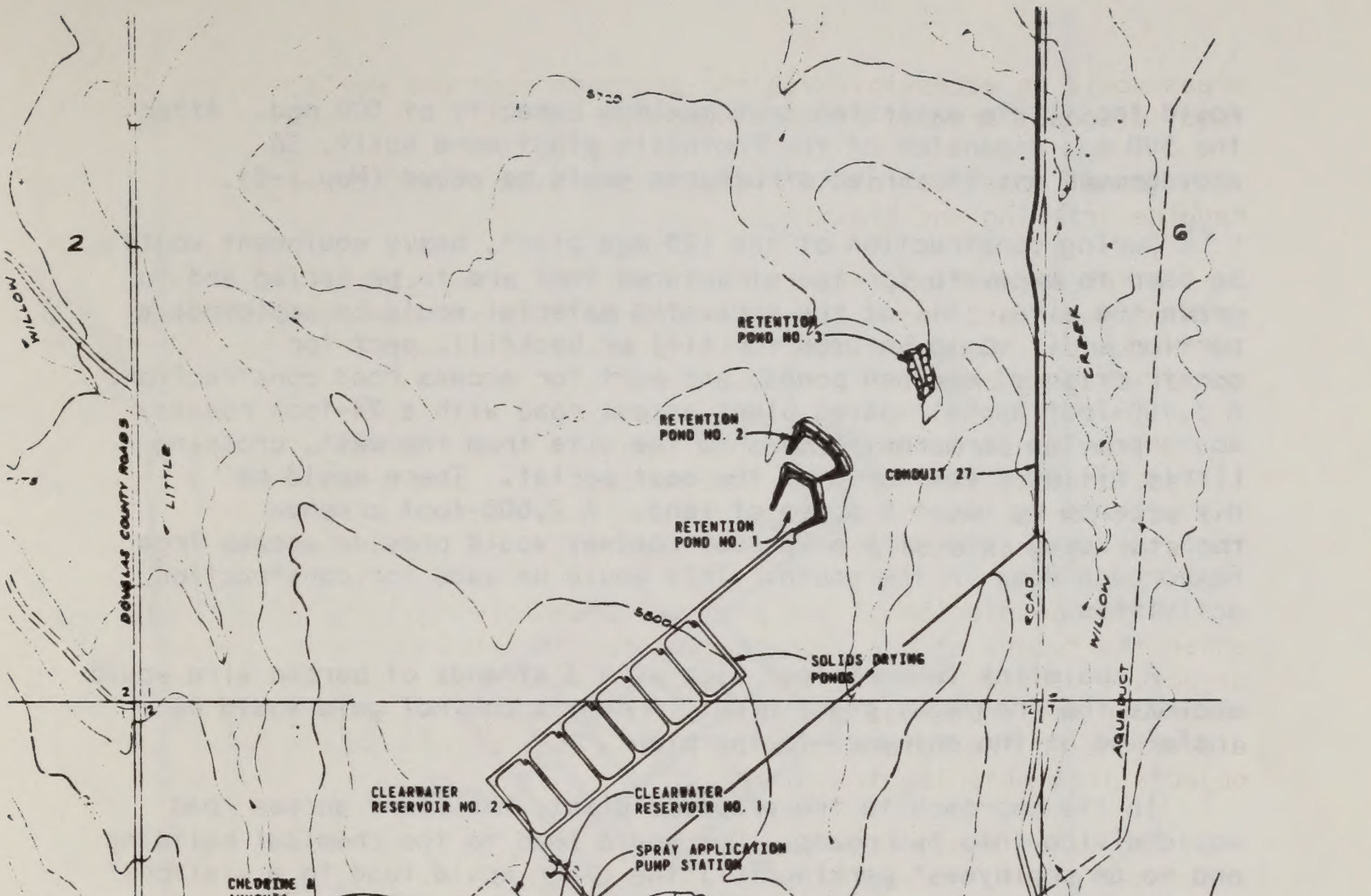
The water would flow through the tunnel, by gravity, to the treatment plant, protected by a surge chamber. This control chamber, or pocket, would prevent damage to the tunnel lining from a hydraulic surge, or water hammer, which is produced by changes in the rate of flow.

Maintenance crews could enter the structure at Stevens Gulch and the east portal with motorized vehicles via the service doors for routine inspections and for needed repair of the tunnel.

Treatment Plant Complex

Conduit No. 26, a buried pipeline 10.5 feet in diameter, would be connected to the east portal of the proposed Foothills Tunnel. The line would extend 1,721 feet in an easterly direction to the proposed treatment plant. The undercrossing at Little Willow Creek would be protected by a concrete saddle. In addition, one conduit of 54 inches and 60 inches in diameter and 2,450 feet and 1,500 feet in length would connect to the Aurora Rampart Reservoir.

Access roads and 25 aboveground and 9 buried structures would occupy about 65 acres at the proposed 125 mgd treatment plant (Map 1-6). A septic tank and drainfield system would be constructed on the site for disposal of sanitary waste during plant operation. The plant would be designed to treat 125 mgd initially, but the design



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0 500' 1000'

PROPOSED LAYOUT – TREATMENT PLANT COMPLEX AT 125 MGD

MAP 1-6

PREPARED BY FOOTHILLS PROJECT CONSULTANTS

would facilitate expansion to a maximum capacity of 500 mgd. After the 500 mgd expansion of the Foothills plant were built, 36 aboveground and 14 buried structures would be added (Map 1-7).

During construction of the 125 mgd plant, heavy equipment would be used to excavate for the structures that are to be buried and to grade the site. All of the excavated material would be employed; a portion of it would be used for fill or backfill, part for construction of earthen ponds, and part for access road construction. A 3,700-foot asphalt-paved plant access road with a 24-foot roadway would provide permanent access to the site from the west, crossing Little Willow Creek north of the east portal. There would be disturbance to about 6 acres of land. A 2,600-foot crushed rock-surfaced road with a 28-foot roadway would provide access from Roxborough Road in the south. This would be used for construction activities.

A chainlink fence 6 feet high with 3 strands of barbed wire would enclose the treatment plant area. A remote control gate would be installed at the entrance to the plant.

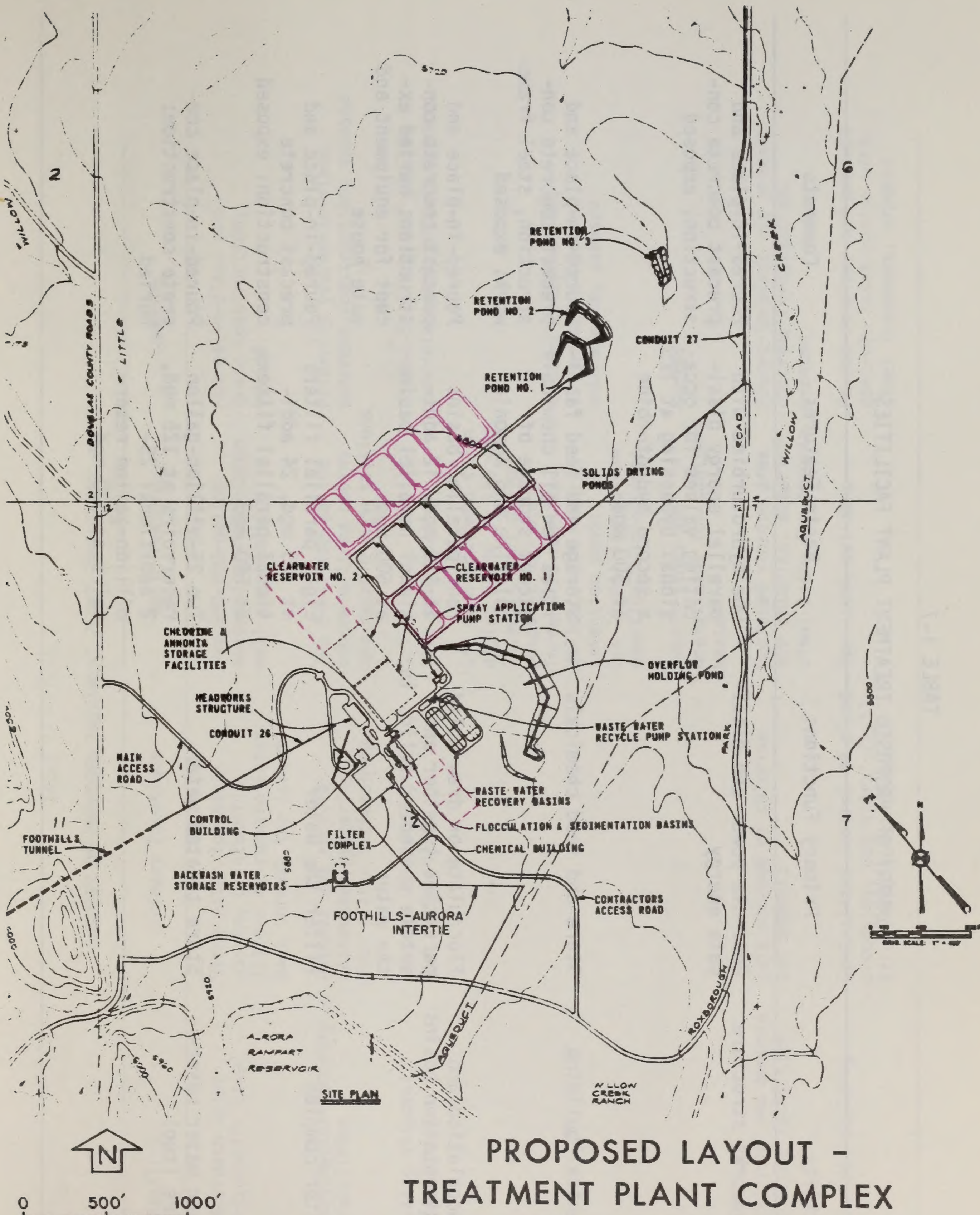
In its approach to the proposed plant, the plant access road would divide into two roads. One would lead to the chemical building and to an employees' parking lot; the other would lead to a visitors' parking area at the control building.

Preparation of footings would involve 5 to 40 feet of excavation so that foundations would rest on suitable material. Excavations for footings would be backfilled and compacted with granular material from onsite excavations.

Portions of all structures below finish-grade would be constructed of poured-in-place concrete. Above-grade portions of structures would be constructed primarily of precast exposed aggregate panels, or poured-in-place, textured, colored concrete. Columns and frameworks for support of wall panels and roof systems would be of poured-in-place concrete or steel construction. Roof systems would be of precast concrete on steel frame and deck construction covered with rigid insulation and built-up roofing materials.

Except for the roads, the same design characteristics would apply to the 500 mgd expansion of the plant. The major facilities are summarized and described in Table 1-7.

The proposed 125 mgd construction operations would include site grading, excavating, trenching and backfilling, pouring of concrete, erecting of buildings, and installing of equipment. Crawler tractors with rippers, compactors, scrapers, backhoes, and trucks would be required for this earthwork. Cranes, "cherry pickers," compressors, and trucks would also be used to construct the buildings and the



PROPOSED LAYOUT - TREATMENT PLANT COMPLEX AT 500 MGD

MAP 1-7

PREPARED BY FOOTHILLS PROJECT CONSULTANTS

TABLE 1-7

SUMMARY OF PROPOSED TREATMENT PLANT FACILITIES

Facility	Primary Functions	Basic Features	Comments
Headworks structure	Generate power and dissipate energy	One hydroturbine with parallel energy dissipating valves for occasional bypassing at 125, a second hydroturbine at 500 mgd	Poured-in-place and precast concrete construction; exposed
Chemical building	Store and feed chemicals	Storage and feed facilities for all chemicals except storage of chlorine and ammonia	Poured-in-place and precast concrete construction, steel framework; exposed
Flocculation and sedimentation basins	Flocculate or draw solid particles together and settle suspended solids in the water	Four parallel basins at 125 mgd, 12 additional parallel basins at 500 mgd	Poured-in-place and precast concrete construction; buried except for equipment and gate house
Filter complex	Filter the water	Eight parallel filters at 125 mgd, 24 additional parallel filters at 500 mgd	Poured-in-place and precast concrete construction; exposed
Clear water reservoirs (two)	Store treated water	Two 25-million-gallon reservoirs at 125 mgd, 2 additional 25-million-gallon reservoirs at 500 mgd	Poured-in-place concrete construction; buried

TABLE 1-7 (cont.)

SUMMARY OF PROPOSED TREATMENT PLANT FACILITIES

Facility	Primary Functions	Basic Features	Comments
Backwash water reservoirs (two)	Store water for backwashing or cleaning filters by running water back through the system	Two 500,000-gallon reservoirs with common well construction	Poured-in-place concrete construction; buried
Wastewater recovery facilities	Recover and recycle wastewater primarily from filter backwashing	Two 2-million-gallon concrete-lined basins and recycle pump stations	Primarily poured-in-place concrete construction; exposed
Waste disposal facilities	Dispose of waste waters and waste solids	Solids spray application pump station	Poured-in-place and precast concrete construction; exposed
		-Six sand-bottomed solid drying ponds at 125 mgd, 12 additional drying ponds at 500 mgd	
		-Three 0.75-million-gallon waste water retention ponds	Earthen construction, 33 percent slope on embankments; exposed
		-One 12-million-gallon overflow holding pond	
		Septic tanks and drainfields for sanitary wastes	Buried
Chlorine and ammonia storage facilities	Bulk storage of chlorine and ammonia	Enclosed storage area for chlorine, exterior steel tanks for ammonia	Poured-in-place and precast concrete construction; exposed
Control building	Centralized control of plant processes, operators' facilities, visitors' center	Two-level building	Poured-in-place and precast concrete construction with steel framework; exposed

underground pipe. This equipment would also be used to construct the mechanical facilities for the plant. Trucks and other earthwork equipment would be used for the backfill and final landscaping. Temporary, portable sanitary facilities would be provided by the contractor on the construction site. These facilities would be serviced on a regularly scheduled basis by a reputable subcontractor.

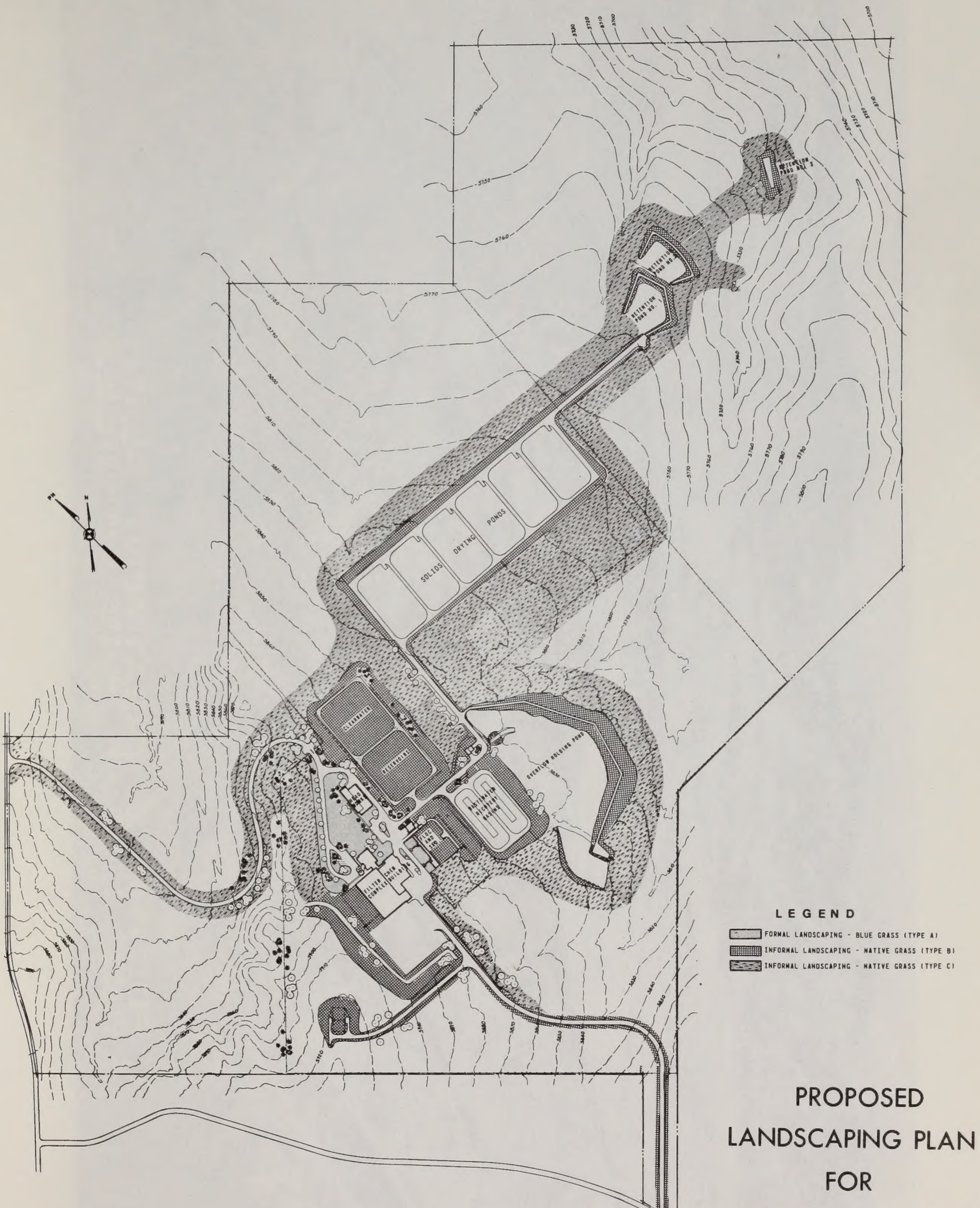
The above discussion of operations will also apply to the 500 mgd expansion.

Landscaping of open spaces would involve reshaping disturbed areas, replacing topsoil, and establishing vegetation to provide a natural appearance. The impacted land would total an estimated 80 acres at 125 mgd and 90 acres at 500 mgd. Landscaping and rehabilitation of the 125 mgd proposed treatment site would be based on the conceptual layout illustrated in Map 1-8 and Figure 1-11. Ultimately, formal landscaping near buildings would be limited to approximately 4 acres and would consist of lawn, trees and ornamental shrubs, and include a fixed irrigation system.

The treatment plant complex would rely entirely on gravity-fed water flows, as diagrammed in Figure 1-12. If an emergency required rapid closing of the plant's influent valves, excess flow, caused by the slow closing of the energy dissipation valves, would be allowed to overflow from the headworks structure to an onsite holding pond. From the holding pond, the stored excess flow would be discharged to the drainage and low retention pond at about 35 cubic feet per second (cfs). Maximum flow from the raw water conduit would be 1,160 cfs.

A hydroturbine installed in the headworks structure between Conduit No. 26 and the treatment plant would help dissipate energy from water flowing through the tunnel and would produce electricity for operation of the plant. The generator for the 125-mgd treatment facility should produce power in the range of 1,050 to 1,600 kilowatt-hours at 125 mgd and 2,200 to 4,700 kilowatt-hours at 500 mgd, depending upon flow through the filter plant. Using the mean production hour of 1,325 kilowatt-hours at 125 mgd, 3,262 kilowatt-hours at 500 mgd, 24 hours-per-day, 365 days-per-year, the average annual power production would approximate 11 million kilowatt-hours at 125 mgd and 78 million kilowatt-hours at 500 mgd. With filter plant power consumption of 8 million kilowatt-hours at 125 mgd, there would be a surplus of 3 million kilowatt-hours of electrical energy for sale annually. At 500 mgd, the filter plant would consume 13 million kilowatt-hours, with a surplus of 65 million kilowatt-hours for sale. Additional powerlines would not be necessary to distribute excess generated power.

The proposed Foothills Plant would be geared for complete treatment, including coagulation, sedimentation, filtration, and disinfection. Water quality goals proposed for the plant are shown in



PROPOSED LANDSCAPING PLAN FOR FOOTHILLS TREATMENT PLANT SITE

MAP 1-8

PREPARED BY FOOTHILLS PROJECT CONSULTANTS

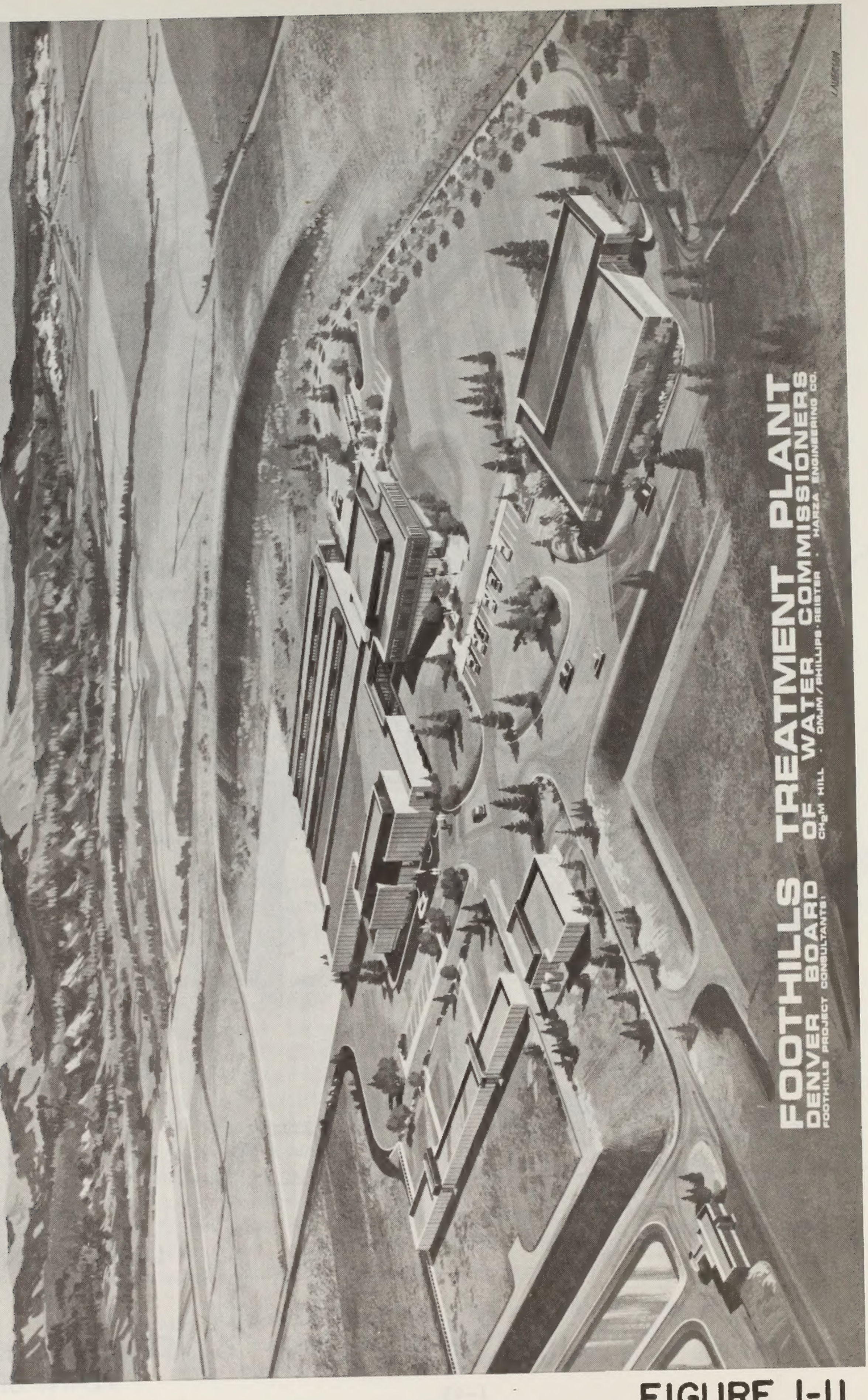

FOOTHILLS TREATMENT PLANT
DENVER BOARD OF WATER COMMISSIONERS
FOOTHILLS PROJECT CONSULTANTS: CH2M HILL · DMJM/PHILLIPS·REISTER · HARZA ENGINEERING CO.

FIGURE I-11

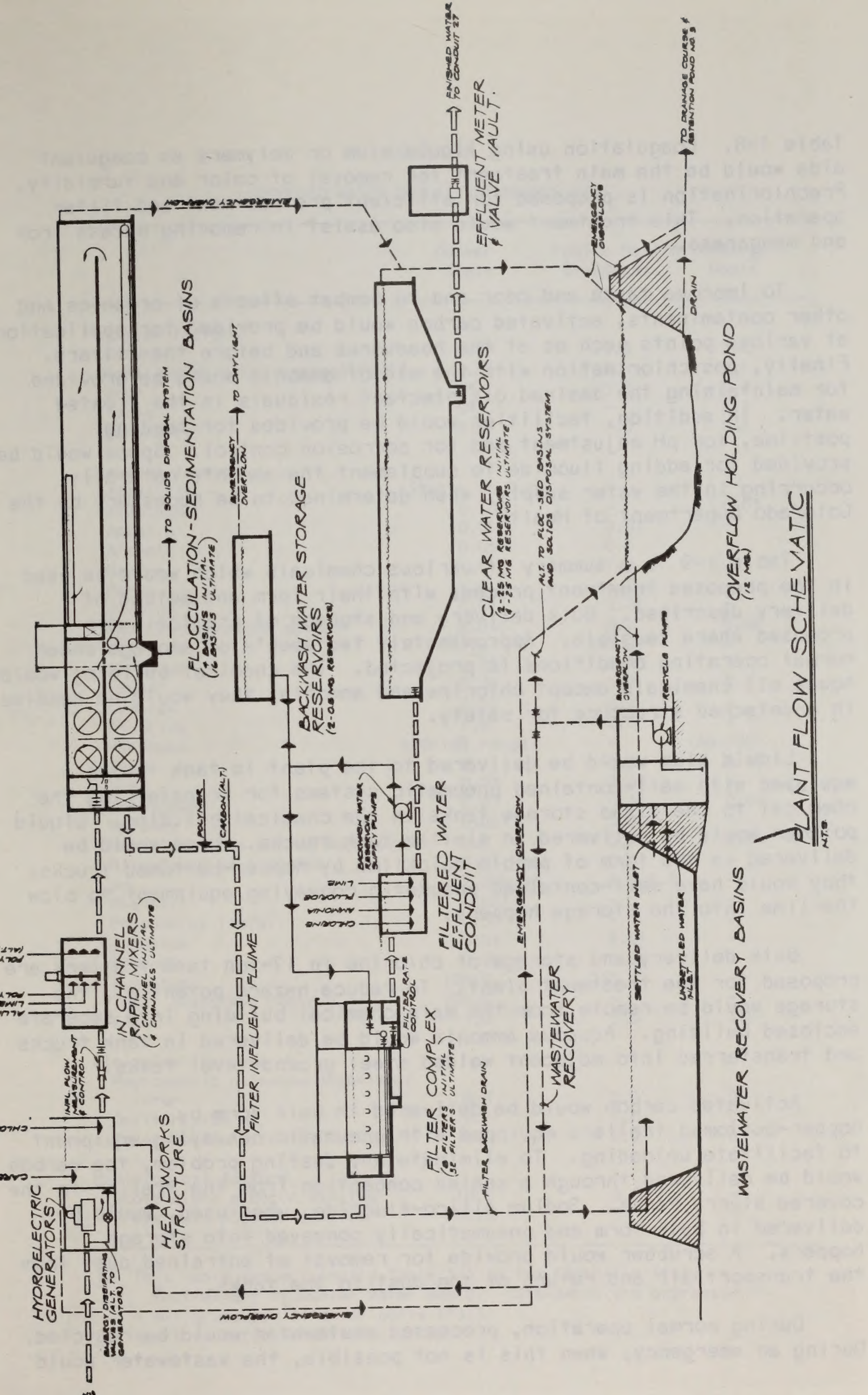


FIGURE 1-12

PREPARED BY FOOTHILLS PROJECT CONSULTANTS

Table 1-8. Coagulation using liquid alum or polymers as coagulant aids would be the main treatment for removal of color and turbidity. Prechlorination is proposed for efficient pretreatment and filter operation. This treatment would also assist in removing excess iron and manganese.

To improve taste and odor and to combat effects of organics and other contaminants, activated carbon would be provided for application at various points such as at the headworks and before the filters. Finally, postchlorination with the aid of ammonia would be provided for maintaining the desired disinfectant residuals in the treated water. In addition, facilities would be provided for feeding postlime, for pH adjustment and for corrosion control. Space would be provided for adding fluoride to supplement the amounts naturally occurring in the water supply, when determined to be necessary by the Colorado Department of Health.

Table 1-9 is a summary of various chemicals which would be used in the proposed treatment process with their form and method of delivery described. Bulk delivery and storage of chemicals are proposed where feasible. Approximately two week's of storage under normal operating conditions is projected. The chemical building would house all chemicals except chlorine and ammonia; they would be handled in a detached structure for safety.

Liquid alum would be delivered to the plant in tank trucks equipped with self-contained pneumatic systems for transferring the chemical to the fixed storage tanks in the chemical building. Liquid polymer would be delivered in similar tank trucks. Lime would be delivered in the form of pebble quicklime by hopper-bottomed trucks; they would have self-contained pneumatic conveying equipment to blow the lime into the storage hoppers.

Bulk delivery and storage of chlorine in 17-ton tank trailers are proposed for the treatment plant. To reduce hazard potential, the storage would be remote from the main chemical building in a separate enclosed building. Aqueous ammonia would be delivered in tank trucks and transferred into adjacent welded steel ground-level tanks.

Activated carbon would be delivered in bulk form by hopper-bottomed trailers equipped with pneumatic conveying equipment to facilitate unloading. To eliminate any dusting problem, the carbon would be delivered through a sealed connection from the trailer to the covered slurry tanks. Sodium silico-fluoride, when used, would be delivered in bulk form and pneumatically conveyed into storage hoppers. A scrubber would provide for removal of entrained dust from the transport air and return of the dust to the tanks.

During normal operation, processed wastewater would be recycled. During an emergency, when this is not possible, the wastewater would

TABLE 1-8

PROPOSED WATER QUALITY STANDARDS 1/

	Denver Goals	Public Health Standards	AWWA 2/ Goals
Physical factors			
Color	3.0*	15.0	3.0
Nonfilterable (suspended) residue	0.1	0.1	0.1
Odor	0*	3.0	0.0
Taste	0*	-	0.0
Turbidity	0.3*	1.0	0.1
Chemical factors			
Alkalinity	(Stable to 0.1)	-	-
Aluminum	0.10	-	0.05
Ammonia	0.01	0.01	-
Arsenic	0.05	0.1	-
Barium	1.0	1.0	-
Boron	1.0	1.0	-
Cadmium	0.01	0.01	-
Carbon chloroform extract	0.04	0.7	0.04
Chloride	50.0	250.0	-
Chromium	0.05	0.05	-
Copper	0.20	1.0	0.2
Cyanide	0.01	0.2	-
Fluoride	1.0	2.5	-
Hardness	(80-100 range)	-	(80-100)
Iron	0.1	0.3	0.05
Lead	0.05	0.05	-
Manganese	0.05	0.05	0.01
Mercury	0.001	0.002	-
Methylene blue active substances	0.2	0.5	0.2
Nitrates plus nitrates	10.0	10.0	-
pH	7.2-8.0*	6.0-8.5	-
Phenols	0.001	-	-
Phosphorus (total)	0.50	-	-
Selenium	0.01	0.01	-
Silver	0.05	0.05	-
Sulfates	100.0	250.0	-
Total dissolved residue	200.0	-	-
Zinc	1.0	5.0	1.0
Biological factors			
Macroscopic nuisance organisms/liter	0.0	0.0	0
Coliform/100 ml	0.1	1.0	0
Fecal coliform/100 ml	0.0	0.2	0
Radiological factors			
Gross alpha picocuries/liter	10.0	0.5	-
Gross beta picocuries/liter	100.0	5	-

1/ This table was originally Table 3-3 in the Foothills Study Preliminary by Denver Water Board. (Standards are expressed in miligrams per liter or units (*).)

2/ American Water Works Association

TABLE 1-9

CHEMICALS TO BE USED IN PROPOSED TREATMENT PLANT AND METHODS OF PROPOSED DELIVERY AND STORAGE

Chemical	Form & Delivery	Frequency of Delivery 125 mgd	500 mgd	Hazards and Precautions
Alum	Liquid; truck	5 days	1 day	Acid spill; drains provided
Polymer	Liquid; tank truck	50 days	6 days	Mild acid
Lime	Pebble, bulk; truck	5 days	1 day	None
Chlorine	Compressed gas; tank trailer	16 days	2 days	Toxic; isolated, ventilated leak detection, alarm
Ammonia	Aqua (liquid); tank truck	30 days	3 days	Toxic; isolated, ventilated
Carbon	Dry powder, bulk; truck	40 days	5 days	None
Fluoride	(Will not be used initially; provision for fluoride application will be made with use and frequency of delivery as established by the Colorado Department of Health.)			None

be released to a series of retention ponds located on the north end of the plant site. These ponds would provide sedimentation and natural purification prior to the release of the wastewater downstream.

All waste solids in the proposed system would normally be withdrawn from the sedimentation basins and applied in shallow layers in the solids drying ponds. Requirements for the probable solids disposal are indicated in Table 1-10. Natural freezing of waste solids would occur during the winter months. The characteristics of waste solids from alum coagulation undergo a marked change when subjected to complete freezing and thawing. They lose their gelatinous character and assume an appearance of dried coffee. Rapid dewatering and drying are promoted because these solids settle, thicken, and dry much more rapidly. Solids would be removed on an annual or semiannual basis.

After a lagoon reached its maximum capacity, the water cover would be drained from the surface and valves on the underdrain system would be opened. Water would be drained to the lower retention ponds which would function to remove the remaining settleable solids and stabilize the wastewater prior to release. Front loaders or scrapers would then remove the concentrated solids, which would be transported to one of two possible disposal sites. One site is located in an abandoned limestone quarry in the SE$\frac{1}{4}$ of Section 2, Township 7 South, Range 69 West (Map 1-2). The second site would be located on DWB-owned property in the NE$\frac{1}{4}$ of Section 34, Township 6 South, Range 69 West (Map 1-2). In either case, the sludge would be transported to the disposal site where it would be dumped and covered with soil. As each section is filled, the earth cover would be replaced and graded so the site would conform as nearly as possible to original contour. The site would then be seeded. The amount of dry sludge produced over the life of the project, 75 years, would be an estimated 101,288 cubic yards at 125 mgd and 640,575 cubic yards at 500 mgd. This would approximately level a 6-acre disposal pit at 125 mgd and a 38-acre pit at 500 mgd.

Access to the treatment plant would be controlled at the single-entry point provided. Two-way communication with visitors would be possible from the control building prior to their admittance. The operator would have visual contact from the office area with all vehicles that approach the parking complex.

All control functions required to operate the plant, including filter backwash, would be controlled from a central control room within the plant. Using a direct digital, computer-based operation, one man would be able to monitor and control the treatment processes throughout the plant. This system allows for ultimate integration into the general DWB system.

TABLE 1-10

SLUDGE PRODUCTION FROM THE OPERATION OF THE PROPOSED TREATMENT PLANT DURING BASELOAD OPERATION

Condition	Quantity as Dry Solids (lb/day) (125 mgd)	Quantity as Dry Solids (lb/day) (500 mgd)	Quantity as 1% Solids (gal/day) (125 mgd)	Quantity as 1% Solids (gal/day) (500 mgd)	Quantity as Dry Solids (Cubic yd/day) (125 mgd)	Quantity as Dry Solids (Cubic yd/day) (500 mgd)
Annual Average Day	4,490	28,500	54,424	345,454	3.7	23.4
Average Day During Maximum Month	34,375	99,000	416,666	1,200,000	28	81.5
Average Day During Minimum Month	4,140	8,300	50,181	100,606	3.4	6.83

In addition to the DWB proposal, the Aurora intertie conduit would provide an emergency source of raw water (up to 150 mgd) to the Foothills Treatment Plant from the existing Rampart Reservoir and vice versa. This would allow either water department (Aurora or Denver) to temporarily shut down its tunnel and conduit systems and perform periodic repairs and inspections. It would also provide emergency sources of water if any part of the tunnel, conduit, or intake systems should fail.

Conduit No. 27 and Second Parallel Conduit

Conduit No. 27 is proposed as a buried 108-inch noncorrosive steel or concrete pipeline with a design capacity of 350 mgd that would originate at the Foothills Treatment Plant and extend, in a northeasterly direction, 53,800 feet to the existing Highlands Reservoir and Pump Station (Maps 1-2 and 1-3). An additional 350 mgd capacity conduit would be required for maxhour transmission with treatment plant capacity at 500 mgd. Conduit No. 27 would tie into Conduit 96 and Highlands Reservoir and would extend on about 33,000 feet to Hillcrest Reservoir as a 90-inch pipeline (Maps 1-3 and 1-4). From the treatment plant, the pipeline would parallel Roxborough Park Road for about 5,900 feet and then turn northeast, paralleling the Aurora aqueduct (47,600), which is encased in concrete and crosses under Plum Creek just upstream of the high water line of Chatfield Reservoir. A water quality certification from the Colorado Department of Health and a Section 404 permit from the Corps of Engineers will be obtained prior to the crossing. Conduit No. 27 would pass under the Atchison, Topeka, and Santa Fe Railroad, the Denver and Rio Grande Western Railroad, and U.S. Highway 85. Periodic location markers and human access hatches would be located along the length of the conduit.

Between the proposed treatment facilities and the Highlands Reservoir and Pump Station, a 100-foot right-of-way adjacent to the Aurora aqueduct has been purchased by the DWB for installation of the conduit and its subsequent operation and maintenance.

The right-of-way for the conduit from Highlands to South Colorado Boulevard and Dry Creek Road would be 100 feet wide. It would be parallel and adjacent to the existing Aurora pipeline right-of-way. From Colorado Boulevard and Dry Creek Road to Colorado Boulevard and Euclid Avenue, the conduit would be in the street right-of-way for South Colorado Boulevard. From South Colorado Boulevard and Euclid Avenue to South Holly Street and Princeton Avenue, the conduit would be in an 80-foot DWB right-of-way now used for 36-inch Conduit No. 85. From this point to Quincy Avenue and Happy Canyon Road, the conduit would be in street right-of-way and then on DWB property to Hillcrest Reservoir.

A trench, approximately 15 feet wide and 15 feet deep, would be excavated. Excavated material would be stacked temporarily alongside the trench. The remainder of the right-of-way would be used for temporary pipe storage, working area, and a graded access road. Major drainage crossings would be covered by concrete caps to prevent erosion and protect the conduit. The railroad crossing would require tunneling; whereas streets and highways would be trenched halfway across while traffic uses first the undisturbed and then the backfilled side.

After installation of the conduit, the excavated material would be replaced in the trench and the disturbed area would be reshaped and seeded to establish a suitable vegetative cover. The access road, paralleling Conduit No. 27, would be kept in repair for use during construction of the proposed project and seeded after completion of construction. However, maintenance and inspection crews would continue to use it for operation access. About 115 acres would be disturbed, of which about 5 acres would be along the 5,900-foot segment adjacent to the Roxborough Park Road; 100 acres would be along the segments with no existing access roads, and about 10 acres would be in city streets.

The description of the second conduit parallel to Conduit No. 27 would be exactly the same. The second conduit would be laid adjacent to Conduit No. 27 within the same right-of-way.

After construction, treated water would be stored in the clear water reservoir and metered into Conduit No. 27 on the plant site. Water would flow through Conduit No. 27 by gravity. The water would divide near Highlands Reservoir. About 30 mgd would flow into existing Conduit No. 96 (48-inch main), about 20 mgd would flow into Highlands Reservoir, and the balance of 75 mgd would flow on to Hillcrest Reservoir for storage and distribution when the treatment plant is operating at peak capacity.

Future distribution of the water from the second conduit is unknown.

INTERRELATIONSHIPS

Interrelationships with Other Projects and Proposals

The proposed Strontia Springs Diversion Dam and Reservoir and Foothills Treatment Plant would receive raw water from the DWB's South Platte and Roberts Tunnel systems.

The following discussion addresses existing water developments that are directly or indirectly related to the proposed Foothills Project. Proposed projects that have the potential of providing raw water to the DWB are discussed in Chapter 8.

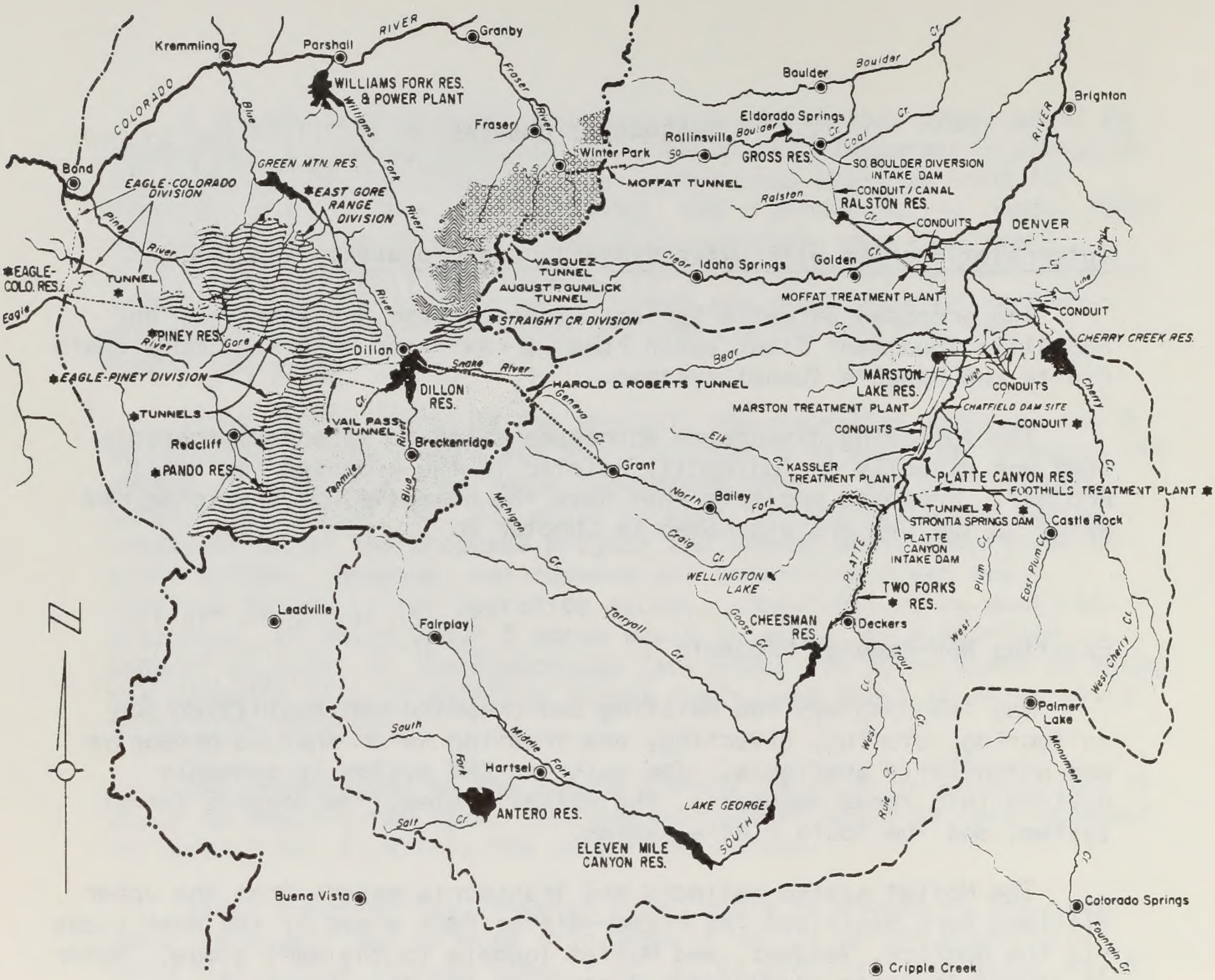
Existing Non-Federal Projects

Map 1-9 displays the existing and proposed DWB facilities for collecting, storing, diverting, and treating water that is presently and potentially available. The existing DWB system is commonly divided into three segments: the Moffat system, the Roberts Tunnel system, and the South Platte system.

The Moffat system collects and transports waters from the upper Williams Fork Basin and the Fraser-Winter Park areas of the west slope via the Gumlick, Vasquez, and Moffat Tunnels to the east slope. Water is stored in Gross and Ralston Reservoirs and from there is transported through pipelines to the DWB raw water users and the Moffat Treatment Plant. In addition, some east slope water from South Boulder Creek and Ralston Creek is diverted for use in the system.

The Roberts Tunnel system collects and stores west slope water from the Blue River, Tenmile Creek, and Snake River. Water is stored in Dillon Reservoir and diverted through Roberts Tunnel, flowing down the North Fork of the South Platte River to Marston and Kassler Treatment Plant intakes.

The South Platte system collects, stores, and diverts east slope water from the South Platte River watershed. Storage in this system is provided by Antero, Eleven Mile, and Cheesman Reservoirs. Water is treated at the Marston and Kassler Treatment Plants.



LEGEND

- CONTINENTAL DIVIDE
- * UNDER STUDY
- BOUNDARY SOUTH PLATTE WATERSHED
- BOUNDARY EAGLE-COLORADO COLLECTION SYSTEM WATERSHED (U.D.)
- MOFFAT TUNNEL (FRASER RIVER) COLLECTION SYSTEM WATERSHED
- ROBERTS TUNNEL COLLECTION SYSTEM WATERSHED
- ROBERTS TUNNEL COLLECTION SYSTEM WATERSHED (U.D.)
- WILLIAMS FORK COLLECTION SYSTEM WATERSHED
- WILLIAMS FORK COLLECTION SYSTEM WATERSHED (U.D.)

DENVER BOARD of WATER COMMISSIONERS

WATER SUPPLY SYSTEM

10 0 10 20 30 40

Approximate Scale in Miles

MAP 1-9

Source: DWB, 1973

Existing Federal Projects

Green Mountain Reservoir, located downstream of Dillon Dam on the Blue River, is operated by the Bureau of Reclamation as part of the Colorado-Big Thompson Project.

There are three Corps of Engineers projects within the Denver metropolitan area that are or will be providing flood control protection and various recreational opportunities.

1. Cherry Creek Dam and Reservoir, located on Cherry Creek in the southeast metropolitan area, has a total storage capacity of 96,000 acre-feet with 81,000 acre-feet reserved for flood control.

2. Bear Creek Lake Dam, under construction and located on Bear Creek east of Morrison, will have a storage capacity of 52,000 acre-feet, primarily for flood control.

3. Chatfield Dam and Reservoir is located on the South Platte River immediately downstream of the confluence with Plum Creek. Total storage capacity at the top of the flood control pool (elevation 5,500 feet) is 235,000 acre-feet. The flood control objective of Chatfield Dam and Reservoir is to control South Platte River flows downstream of the dam to a maximum of 5,000 cfs.

Planned Developments and Proposals

In October 1974, the Bureau of Reclamation published a field draft feasibility report which presented the results of an investigation of the Upper South Platte Unit, Pick-Sloan Missouri Basin Program, Colorado.

The report presented, for public and governmental evaluation, engineering, economic, environmental, and social analyses of alternative water supply plans in the Upper South Platte River Basin. These alternative plans were multipurpose in scope and considered the full development potentials of the resource (hydroelectric power, municipal and industrial water, fish and wildlife enhancement, and outdoor recreation and environmental quality) to help meet the growing needs of the entire Denver metropolitan area and contiguous region. Although the report contained conclusions of the investigation, it did not recommend any administrative action.

Three alternative water storage facilities to provide water service for the entire Denver metropolitan area were evaluated in the investigation: West Plum Creek in the foothills, Ferndale on the North Fork of the South Platte River, and Two Forks on the South

Platte River--about 2 miles upstream from DWB's proposed Foothills Treatment Plant.

Turkshead Dam, to be located 1.9 miles downstream from the Two Forks Dam site, would not be constructed if Strontia Springs were built. However, the primary purpose of Strontia Springs is for diversion of existing water supplies to the proposed Foothills Treatment Plant; it would serve this function independently of any of the Upper South Platte Unit storage alternatives. Strontia Springs Dam is designed with a spillway capable of passing the inflow-design flood without upstream storage. Therefore, the proposed Strontia Springs Dam is compatible with the major storage options studied in the Bureau of Reclamation's report and could serve the afterbay and/or diversion dam purposes outlined there if one of those options were favorably recommended by the Bureau of Reclamation and approved and funded by Congress.

The Two Forks Dam and Reservoir described in Concept A, Chapter 8, is considerably smaller than the Two Forks alternative discussed above, since the 1974 storage alternative would provide regulation of raw water supplies for the entire metropolitan area and for other multipurpose uses (as described earlier). The Foothills Project Concept A requires regulation for only enough raw water to serve a 500 mgd plant.

The DWB owns two conditional decrees for storage rights in the Two Forks Reservoir alternative discussed above. These decrees are for 145,133 and 191,235 acre-feet of water annually; they have appropriation dates of January 18, 1905, and May 1, 1926, respectively. If Two Forks Reservoir were constructed, these rights would become decreed and would be exercised by the DWB.

In 1932, BLM allowed a right-of-way grant for the DWB to construct and operate a dam and reservoir on BLM and Pike National Forest lands. This grant was for a structure similar in location and size to the Bureau of Reclamation alternative mentioned above as Two Forks, except that it would be essentially a single purpose water development for municipal and industrial purposes. The DWB has continued to acquire lands and other rights from private landowners in the area of this right-of-way. However, they have delayed planning and predesign efforts pending a recommendation and decision regarding potential construction of one of the major storage alternatives in the Upper South Platte study area. Should the DWB decide to proceed with these plans as a non-federal project, further federal evaluation would be required to comply with federal statutes and, in particular, the National Environmental Policy Act.

The Narrows Unit was authorized for construction and operation by Congress when it passed Public Law 91-389 on August 28, 1970. The Narrows Unit will be a multipurpose development which will provde

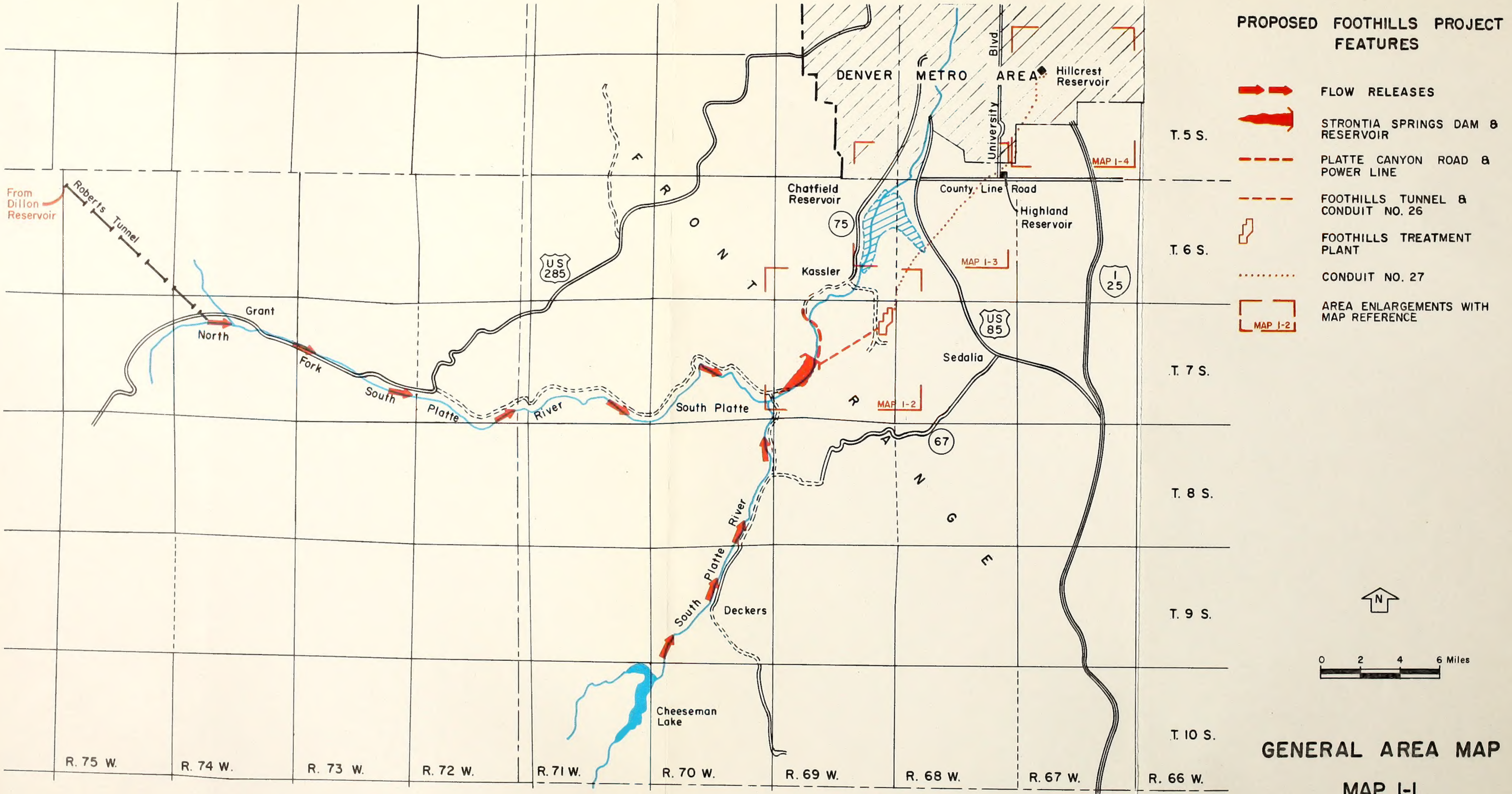
supplemental irrigation water, flood control protection, recreation and wildlife development. A dam and reservoir will be located on the South Platte River near Fort Morgan, Colorado.

Interrelationships with Bureau of Land Management Multiple Use Planning System in the Study Area

No element of BLM's planning system will be initiated in the study area until 1983. At that time, Unit Resource Analysis (BLM Manual 1605) would begin on the Front Range.

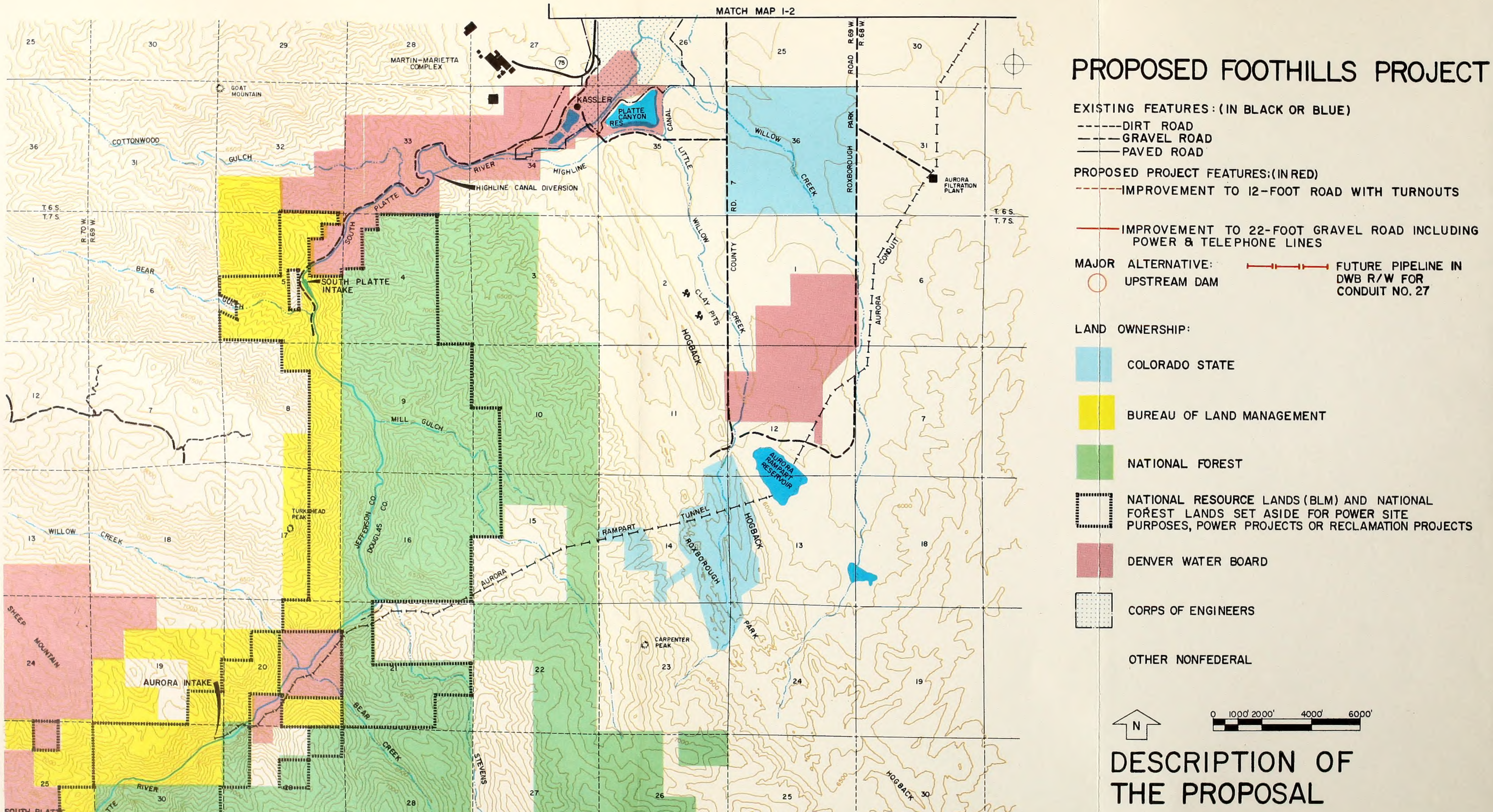
Interrelationships with USFS Multiple Land Use Planning System in the Study Area

The project as proposed is not inconsistent with the existing multiple land use plan for the Pike and San Isabel National Forests within this study area.



GENERAL AREA MAP

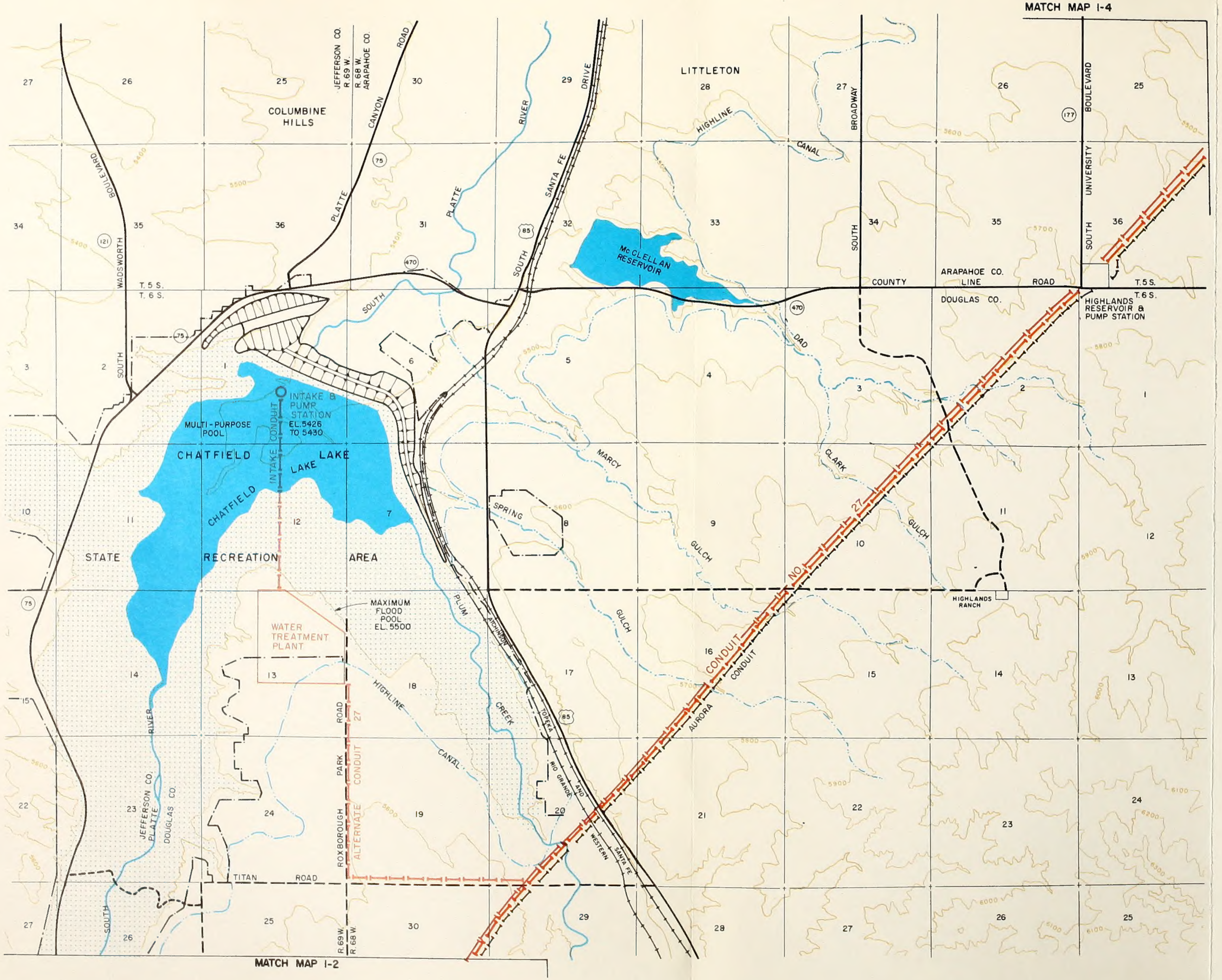
MAP I-1



DESCRIPTION OF THE PROPOSAL

TOPOGRAPHIC MAP- FOOTHILLS

MAP I-2



PROPOSED FOOTHILLS PROJECT

EXISTING FEATURES: (IN BLACK OR BLUE)

------DIRT ROAD
— — — GRAVEL ROAD
——— PAVED ROAD

PROPOSED PROJECT FEATURES: (IN RED)

MAJOR ALTERNATIVE:

CHATFIELD

LAND OWNERSHIP:

CORPS OF ENGINEERS

NONFEDERAL

FUTURE PIPELINE IN DWB R/W FOR CONDUIT NO. 27

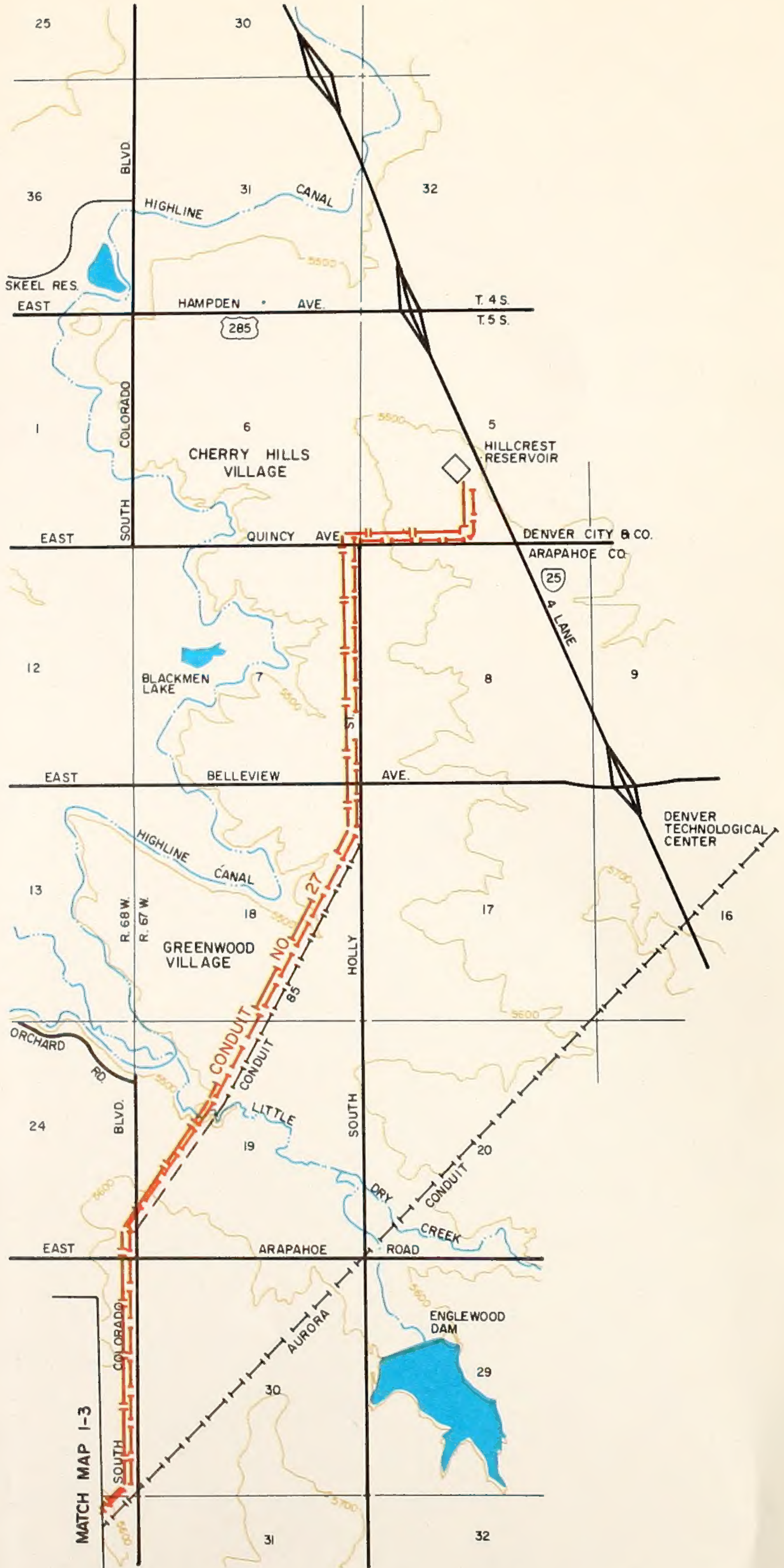
N

0 1000' 2000' 4000' 6000'

DESCRIPTION OF THE PROPOSAL

TOPOGRAPHIC MAP - HIGHLANDS RESERVOIR

MAP I-3



PROPOSED FOOTHILLS PROJECT

EXISTING FEATURES: (IN BLACK OR BLUE)

- - - - - - DIRT ROAD
— — — GRAVEL ROAD
———— PAVED ROAD

PROPOSED PROJECT FEATURES: (IN RED)

LAND OWNERSHIP:

NONFEDERAL

FUTURE PIPELINE IN DWB R/W FOR CONDUIT NO. 27

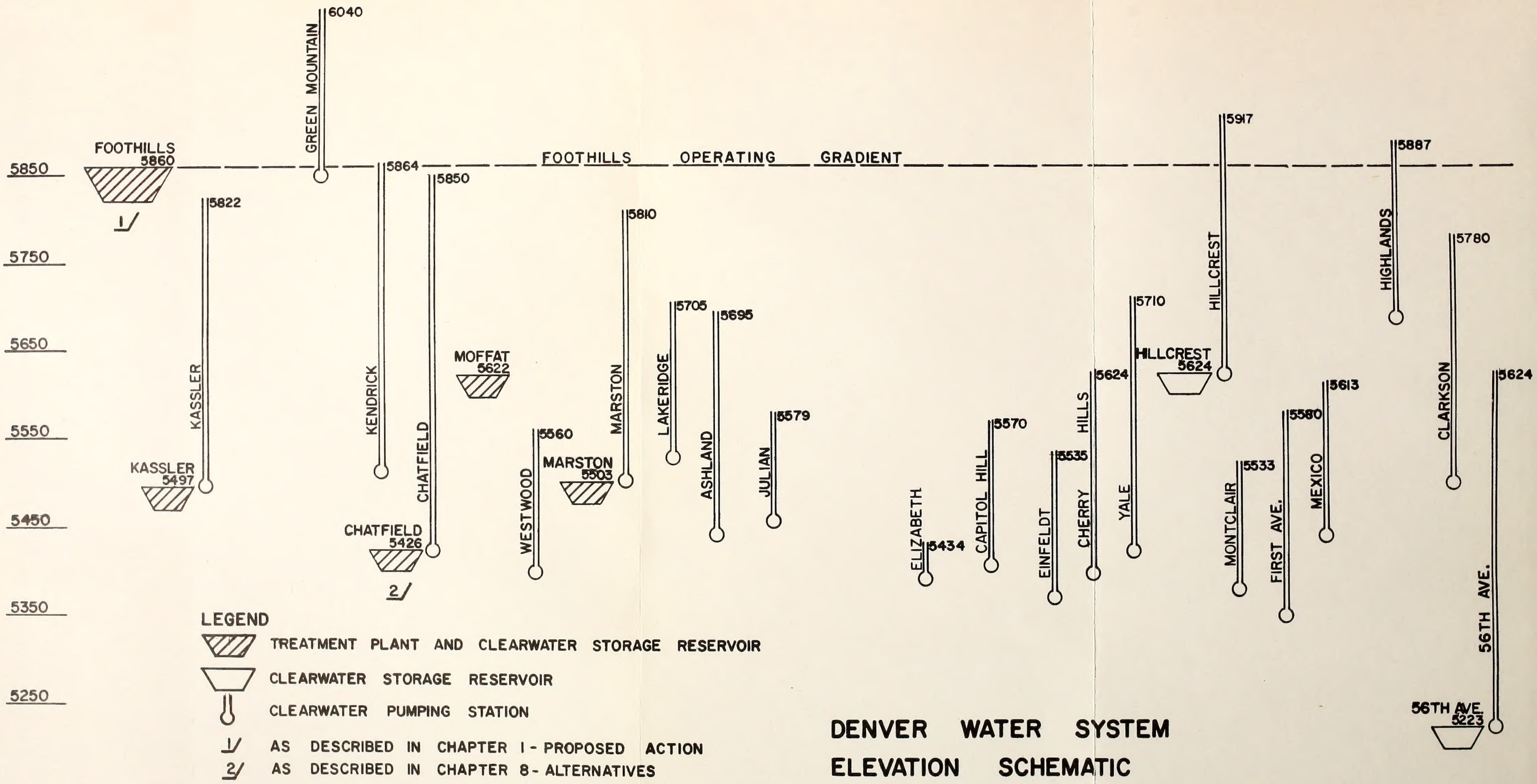
N

0 1000' 2000' 4000' 6000'

DESCRIPTION OF THE PROPOSAL

TOPOGRAPHIC MAP-HILLCREST RESERVOIR

MAP I-4



DENVER WATER SYSTEM ELEVATION SCHEMATIC

FIGURE 1-1

Chapter 2

Description of the Environment

CHAPTER 2

DESCRIPTION OF THE PRESENT ENVIRONMENT

PRESENT ENVIRONMENT

The description of the environment is organized into categories which relate to all classes of land ownership. The aspects of the environment which are described in each category are most likely to be affected by the proposed Foothills Project. The degree of detail used in the description is related directly to the degree of anticipated impacts.

The area that would be affected by the Foothills Project is generally in metropolitan Denver. It includes a linear area extending from Highlands Reservoir in Littleton southwesterly to the proposed treatment plant site near Roxborough Park and the South Platte Canyon from Chatfield Reservoir to South Platte. The North Fork of the South Platte River, Dillon Reservoir, the Blue River and the South Platte River below Denver are affected to a much lesser degree.

SOCIO-ECONOMIC CONDITIONS

Human Populations

The socio-economic environment related to the Foothills Project centers around the Denver metropolitan area and consists of six counties: Adams, Arapahoe, Boulder, Denver, Douglas, and Jefferson. The Denver metropolitan area is the largest in the Rocky Mountain states. The median population in 1970 for the six Denver area counties was 173,965, ranging from 8,407 in Douglas County to 514,678 in Denver County. The total population of the six counties was 1,238,250 (U.S. Bureau of the Census 1973).

In 1975, the estimated median population for the six counties was 213,000, a median increase of 42,150 (27.9 percent). The range decreased because Denver lost population at the top of the range and Douglas at the low end gained. The estimated 1975 range was 15,700 in Douglas County to 489,000 in Denver County. Total population for the six counties in 1975 was estimated at 1,402,500 (U.S. Bureau of the Census

1976). Because of Denver's estimated decline in population, the six counties' estimated percent gain was slightly lower than the state's (13.3 percent compared to 14.7 percent).

The Denver Water Board (DWB) service area occupies a large portion of the six-county Denver area. The actual population of the service area in 1975 was 876,400 which was 62.5 percent of the estimated 1975 population (1,402,500) of the Denver area. Population growth in the six-county area was 13.3 percent during the period 1970-1975, whereas the DWB service area grew 14.1 percent, from 768,000 to 876,400 (DWB Annual Report 1975).

In summary, in 1970 and 1975 the counties in the Denver area, including the city of Denver and Denver County, were for the most part urban, with population densities that would be expected in urban areas. The exception to this was Douglas County, which was still largely rural.

Employment and Manpower

The Denver-Boulder Labor Market Area (DBLMA) seasonally adjusted unemployment rate in March 1977 was 6.5 percent, down slightly from 6.8 percent in March 1976 (Table 2-1). The construction industry accounted for 25.9 percent of all the unemployed in the DBLMA, considerably under the 29.3 percent recorded in March 1976. The DBLMA's labor force grew from 704,200 to 725,600 between March 1976 and March 1977.

Income

Weekly earnings in the DBLMA during 1976 ranged from a low of $90.95 for hotel, tourist court and motel workers to a high of $308.67 for contract construction workers. The median for all workers was $217.09 per week, the equivalent of $11,288.68 if work was attainable for the full year. If contract construction workers worked 52 weeks in 1976 they earned $16,050.84; hotel, tourist court and motel workers under the same circumstances would have earned $4,729.40 (Table 2-2).

Community Attitudes

A BLM staff summary of media reports on attitudes toward the proposed project, other DWB proposed projects, and the results of two elections of DWB proposed projects show that community attitudes are sharply divided. At one pole are the environmentalists, the no growth advocates, the controlled growth groups, and those opposed to transmountain division of west slope water. At the other pole are those who

TABLE 2-1

CHARACTERISTICS OF THE DENVER-BOULDER LMA INSURED UNEMPLOYED 1/

INDUSTRY	TOTAL MAR 1977	TOTAL FEB 1977	TOTAL MAR 1976	PERCENT DISTRIBUTION MAR 1977	PERCENT DISTRIBUTION FEB 1977	PERCENT DISTRIBUTION MAR 1976
TOTAL	14,485	14,544	14,001	100.0	100.0	100.0
Mining	148	181	127	1.0	1.2	0.9
Construction	3,753	4,203	4,103	25.9	28.9	29.3
Manufacturing	2,673	2,538	2,849	18.5	17.4	20.3
Transportation & Public Utilities	649	635	671	4.5	4.4	4.8
Wholesale & Retail Trade	3,277	3,011	2,342	22.6	20.7	16.7
Finance	771	641	694	5.3	4.4	5.0
Services (& Farm)	2,397	2,506	2,297	16.5	17.2	16.4
Other	817	829	918	5.6	5.7	6.6
OCCUPATION						
TOTAL	14,485	14,544	14,001	100.0	100.0	100.0
Prof., Tech., & Mgr.	1,921	1,852	3,096	13.3	12.7	22.1
Clerical	1,260	1,321	1,984	8.7	9.1	14.2
Sales	482	466	738	3.3	3.2	5.3
Services	585	583	932	4.0	4.0	6.7
Processing	373	363	515	2.6	2.5	3.7
Machine Trade	373	330	850	2.6	2.3	6.1
Benchwork	469	401	515	3.2	2.8	3.7
Structural Work	1,542	1,755	3,692	10.6	12.1	26.4
Misc. (Farm)	7,480*	7,473*	1,679	51.6*	51.4*	12.0
AGE						
TOTAL	14,485	14,544	14,001	100.0	100.0	100.0
Under 25	2,673	2,519	2,738	18.5	17.3	19.6
25-34	5,385	5,608	5,497	37.2	38.6	39.3
35-44	2,635	2,513	2,357	18.2	17.3	16.8
45-54	2,108	2,202	1,977	14.6	15.1	14.1
55-64	1,465	1,451	1,320	10.1	10.0	9.4
65 & Over	219	251	112	1.5	1.7	0.8
WEEKS UNEMPLOYED						
TOTAL	14,485	14,544	14,001	100.0	100.0	100.0
1-2	2,975	3,426	3,618	20.5	23.6	25.8
3-4	2,146	2,474	1,880	14.8	17.0	13.4
5-8	3,657	3,594	3,386	25.2	24.7	24.2
9-14	3,252	2,843	2,491	22.5	19.5	17.8
15-19	1,343	1,243	1,186	9.3	8.5	8.5
20 & Over	1,112	965	1,440	7.7	6.6	10.3
SEX						
TOTAL	14,485	14,544	14,001	100.0	100.0	100.0
Male	9,986	10,102	10,048	68.9	69.5	71.8
Female	4,498	4,442	3,953	31.1	30.5	28.2

1/ The characteristics of the insured unemployed are gathered by means of a Statewide 20 percent sample of claimants who filed a continued claim during the survey week of each month. These unemployed claimants filing for, or receiving, unemployment benefits under the Colorado Employment Security Act represent only one segment of the total estimated number of unemployed. Data is tabulated for Local Offices of the Division of Employment which service the counties of Adams, Arapahoe, Boulder, Denver, Douglas, Clear Creek, Gilpin, and Jefferson.

Detail may not add to total due to rounding.

* Due to changes in the computer processing of claims data, an abnormal number of claimants could not be classified as to occupation during the indicated months. Other claimant characteristics are not affected.

TABLE 2-2

HOURS AND EARNINGS FOR SELECTED INDUSTRIES 1/

	DENVER-BOULDER LMA 4/ AVERAGE WEEKLY EARNINGS			AVERAGE WEEKLY HOURS			AVERAGE HOURLY EARNINGS		
	NOV 1976 2/	OCT 1976 3/	NOV 1975	NOV 1976 2/	OCT 1976 3/	NOV 1975	NOV 1976 2/	OCT 1976 3/	NOV 1975
CONTRACT CONSTRUCTION	$308.67	$312.98	$280.80	37.1	37.8	35.1	$8.32	$8.28	$8.00
MANUFACTURING	216.11	218.14	212.66	39.8	40.1	40.2	5.43	5.44	5.29
Durable Goods	216.14	215.87	211.58	40.4	40.5	40.3	5.35	5.33	5.25
Ordnance & Febricated Metals	239.97	237.44	216.37	42.1	42.1	39.7	5.70	5.64	5.45
Machinery, except Electrical	253.76	248.27	238.29	41.6	40.7	42.4	6.10	6.10	5.62
Nondurable Goods	216.06	220.97	213.07	39.0	39.6	39.9	5.54	5.58	5.34
Food & Kindred Products	218.04	229.49	230.60	37.4	38.7	41.4	5.83	5.93	5.57
Printing & Publishing	230.25	224.92	215.97	37.5	37.3	37.3	6.14	6.03	5.79
COMMUNICATION, ELECTRIC, GAS & SANITARY SERVICES	255.33	260.98	236.99	40.4	40.4	40.1	6.32	6.46	5.91
WHOLESALE TRADE	219.23	220.18	214.38	39.5	39.6	39.7	5.55	5.56	5.40
RETAIL TRADE, except Eating & Drinking Places	151.90	150.42	139.38	35.0	34.9	34.5	4.34	4.31	4.04
FINANCE & INSURANCE CARRIERS	168.84	168.86	163.12	-	-	-	-	-	-
HOTELS, TOURIST COURTS, & MOTELS	90.95	90.91	90.55	31.8	33.3	31.7	2.86	2.73	2.86
LAUNDRIES & DRY CLEANING PLANTS	101.87	103.36	107.54	34.3	34.8	37.6	2.97	2.97	2.86

1/ Averages, prepared in cooperation with the Bureau of Labor Statistics, based upon data for full and part-time production, working supervisory, and related employees who worked during the pay period including the 12th of the month. Average earnings are computed on a "gross" basis and may reflect change in basic hourly and incentive wage rates. Average hourly earnings are not wage rates but averages of gross earnings of all employees below administrative level.

2/ Preliminary estimates for November 1976.

3/ Revised.

4/ Includes Adams, Arapahoe, Boulder, Denver, Douglas, Clear Creek, Gilpin, and Jefferson counties.

Source: Larson 1976

wish development of the Denver area to continue without a change in the area's lifestyle or, perhaps, the establishment of a more elaborate lifestyle, especially that related to horticulture and recreation (a definition of lifestyles is included in the Glossary in Volume 2 of this FES). The latter group believes plentiful inexpensive water is necessary for this development. There is also a proponent group that favors the development but desires to minimize damage from the construction of the project.

Opinions concerning the project are not necessarily related to the holder's geographic location. Public opinion in the DWB service area is mixed; however, west of the Continental Divide, opinion generally opposes projects that would divert west slope water to the east slope.

The intensity of positive or negative opinions toward the project do not emanate from large numbers of people. On both sides, the proposed project and other DWB projects have been discussed within the public realm, mostly by interested minorities. In the city and county of Denver, a bond issue for DWB capital improvements, of which the Foothills Treatment Plant was a part, was voted upon in a special election in July 1972. At that time, 218,533 voters were registered, but only 50,933 (23.3 percent) turned out for the election. Affirmative votes were cast by 23,595 (46.3 percent) of the participating voters, representing 10.8 percent of the eligible voters; negative votes were cast by 27,349 (53.7 percent) of the participating voters, representing 12.8 percent of the registered voters. Of the eligible voters, 167,589 (76.6 percent) did not participate (personal communication, Pundt 1977).

A second similar but not identical DWB capital improvement bond issue special election was held in November 1973. A group called the Sensible Water Use Coalition opposed the bond issue, and a group called the Water for Denver Committee supported it. There were 291,582 voters registered within the city and county of Denver in November 1973. Of these registered voters, 70,122 (24.0 percent) voted on the bond issue. Affirmative votes were cast by 39,274 (56.0 percent) participating voters, representing 13.4 percent of all registered voters; negative votes were cast by 30,848 (44.0 percent) participating voters, representing 10.6 percent of the registered voters. Of the eligible voters, 221,460 (76 percent) did not vote. The 24 percent turnout of the registered voters was 2.84 percent points, or 13.4 percent higher than the average 21.16 percent 20-year average turnout for single issue elections in Denver. Despite the higher turnout of voters in the second election, an examination of the voting statistics indicates that the protagonists in both elections were unable to stimulate three-quarters of the Denver electorate to vote on the bond issues. This confirms the observation that, at the time of the elections, water development was a subject of interest to a minority of the public.

A public opinion poll using funds provided by Water for Colorado, A Citizen's Committee, Incorporated, was conducted by telephone between August 31 and September 4, 1977, among 253 residents of four counties in

the Denver Area--90 residents in the city and county of Denver, 53 residents in Adams County, 50 residents in Arapahoe County, and 60 residents in Jefferson County. This poll asked questions relating to treated water and to factors responsible for bringing people to Colorado (4-C Company 1977), the latter question being pertinent to Chapter 3, Assumption 7, of this statement. Douglas and Boulder Counties which were included in this statement's study area were not included in the survey. The 4-C Company which did the survey believed that since there were few DWB customers in Boulder County, it should not be included in the survey; however, Douglas County should have been included since part of the proposed project is in that county.

The survey asked the following specific question: "Water Policy has been much in the news lately. For a moment, place yourself in the position of a local policymaker who must do something to solve shortage of treated water for home consumption which will happen in a few years. Which one of the following items is the most important action to be taken? . . ."

Respondents gave the following percents of affirmative answers to the list of options presented to them:

	Percent
Begin construction of new water treatment plants	53
Plan for water use restrictions	25
Prohibit any new water service	10
Increase rates until water use decreases	2
Other remedies mentioned	6
Don't know/no comment	4

It can be seen from the gross statistics, a majority of the respondents gave affirmative answers to the construction option.

The county of residence tabulations were as follows:

	Denver (Percent)	Adams (Percent)	Arapahoe (Percent)	Jefferson (Percent)
New treatment plants	43	53	60	62
Water use restrictions	31	21	18	25
Prohibit any new water service	13	13	8	5
Increase rates	2	6	-	-
Other remedies mentioned	7	4	10	5
Don't know/no comment	3	4	4	3

It can be observed from the foregoing that in the suburban counties where there is more irrigated horticulture per dwelling, the majority gave affirmative answers to the option of the new water treatment plant. However, in the city and county of Denver where irrigated horticulture per dwelling is smaller and where the bond issue votes were taken in 1972 and 1973, a minority gave affirmative answers.

It should be noted that the survey had several inadequacies: (1) It did not clearly and specifically present all the treated water alternatives available, (2) it did not state who would bear the cost of new water treatment plants, (3) it did not state why and when there would be water shortages, (4) it did not ask the respondents directly which of the options presented they favored, and (5) it omitted Douglas County, in which part of the proposed project would be located.

In summary, it can be stated that the most salient point about community attitudes is public apathy toward water development projects. In spite of intense publicity campaigns, three quarters of the registered voters did not vote in the 1972 and 1973 bond issue elections. This apathy showed up in the 1977 4-C study, too. Even though water shortage problems were the stated modal category of concern among the sample of respondents in four metropolitan counties, only 19 percent of the sample expressed concern about them. Even law enforcement problems which are given considerable exposure in the media were of concern to only 10 percent of the sample. The real modal category in the 4-C study was "don't know/no comment" (21 percent of the sample fell into this category). Apparently, water development is of interest only to an interested minority of the public in the Denver area.

Lifestyles

Figures obtained from the 1970 census indicate that approximately 10.0 percent of the population in the six-county Denver area had annual incomes below the poverty level and about 1.0 percent had annual incomes of $50,000 or more (U.S. Bureau of the Census 1973).

More recent poverty-affluency figures have not been published by the Census Bureau, but a rough estimate of the poverty level can be calculated from Colorado Department of Social Services data (personal communication, Division of Income Maintenance, Colorado State Department of Social Services 1977). The affluency level can be estimated from the Bureau's most recent per capita income estimates.

Data from the Colorado Department of Social Services show that the percent of population receiving public assistance during fiscal years 1975-1976 was as follows: Adams County, 9.8 percent; Arapahoe County,

3.4 percent; Boulder County, 5.3 percent; Denver County, 17.0 percent; Douglas County, 1.8 percent; and Jefferson County, 3.4 percent. The average for the six counties was 6.8 percent.

The population receiving public assistance does not constitute the entire population designated at the poverty level or less. There are two other groups included in the category: those not receiving public assistance who receive food stamps and, a perhaps smaller group, the poor who are eligible for food stamps and/or public assistance but who do not apply for either. The Department of Health, Education and Welfare has defined the 1976 poverty level as being an annual income of $5,500 or less for a nonfarm family of four.

Colorado Department of Social Services statistics (personal communication, Branch of Food Stamps, Colorado State Department of Social Services 1977) show that the number of nonpublic assistance persons receiving food stamps in the six-county Denver area during February 1977 was 42,684, or approximately 3.0 percent of the estimated total population.

Presently available statistics do not show the number and percent of persons eligible for public assistance and/or food stamps who do not apply.

Combining the percent of population receiving public assistance and those not on public assistance receiving food stamps, it can be assumed that a minimum of 9.8 percent of the population in the six-county area is at the poverty level or below. This figure undoubtedly would be higher if data were known on those eligible for public assistance and food stamps who do not apply.

The Bureau of the Census has not released affluency statistics by county more recently than 1970. However, the Bureau has released estimated average per capita income figures for 1974 (Bureau of Census 1977). These show that the average per capita income in Adams County was $4,531; in Arapahoe County, $5,720; in Boulder County, $5,060; in Denver County, $5,585; in Douglas County, $5,116; and in Jefferson County, $5,625. This constitutes an average per capita income in the Denver area of $5,273. Based on the latter figure, the average income for a family of four would be $21,092. The average per capita income for the state in 1974 was $4,884, which projects to $19,536 for a family of four. Thus, the Denver area population is somewhat (8.0 percent) more affluent than the rest of the state in terms of money income.

Although Denver is in a semiarid region, residents of the area maintain extensive landscaped areas by irrigating with treated water. These landscaped areas are comprised of lawns, trees, shrubbery, and domestic plants, freeway embankments, and green belts. Area residents

place a high value on these irrigated areas. This conclusion was reached by observing how much time and material resources were devoted to cultivating horticulture by Denver area residents. The key variables in this analysis were "free time" and "disposable income," with free time being more important as disposable income increases. Working people find it difficult to increase free time. It was assumed that the average resident has 30 hours of daylight free time in an average summer week (2 hours each work day and 10 hours each on Saturday and Sunday (5 x 2 = 10 + 10 + 10 = 30)). If 1 hour per work day and 2 hours each on Saturday and Sunday is devoted to horticulture (not counting time and money devoted to shopping for horticultural reasons), 30 percent of her/his free time was used for residential horticulture. If one of the household partners did not work outside the home, the amount of daylight time devoted to horticulture was probably greater and, since in this case it was probably done during normal work day hours, it was not included in the free-time category.

After consultation with Wieder (1977), it was conservatively estimated that the average horticultural investment per dwelling unit in the six-county Denver area was $2,000. This amount takes into account smaller plots in Denver county and multiple dwellings throughout the six-county area, as well as parks, golf courses, and highway medians. The average annual income for a family of four in 1974 was $21,091.32 in the six-county area (Bureau of Censes 1977). A $2,000 investment in horticulture per dwelling unit is equal to 9.5 percent of one year's average annual income.

Utilities

Municipal and Industrial Water Systems

In 1977, the DWB system had the capability to deliver 520 million gallons per day (mgd) of treated water to its customers within the service area. There are three treatment facilities having the following capacities:

Moffat Plant	210 mgd
Kassler Plant	50 mgd
Marston Plant	260 mgd
Total	520 mgd

Operational constraints, i.e., turbidity, power outages, etc., do not always allow extended use of the treatment facilities at full capacity. For purposes of demonstrating future operation of the facilities with and without the Foothills plant, it has been assumed that the full capacity would be available to meet the projected demands.

Maximum single-day use during 1964-1973 averaged 480 mgd. However, in 1973 and again in 1975 the maximum-day use exceeded the available treatment capacity of 460 mgd and of 490 mgd, respectively. On that occasion, in 1973 the max-day demand was 506 mgd and in 1975 it was 500 mgd. Treated water stored within the DWB transmission system was used to satisfy the additional demand. Reductions of pressures and other operational problems occurred as a result of this overextension of system capacity.

The treated-water storage capacity within the DWB transmission system as of 1975 was 287.8 million gallons. Consumption rates of treated water in the DWB treated-water service area range from a monthly low average of 117 gdc (gallons per capita per day) in January to a high of 370 gdc in July. In 1973 per capita use of treated water reached a high of 608 gallons on a single day.

The average annual treated-water use rate for the period 1971-1975 was 215 gdc (181 mgd), which reflected all uses of treated water within the DWB treated-water service area--residential, commercial, industrial, construction, fire protection, governmental, and transmission system losses. Using data presented in the DWB 1973 Annual Report, 39 percent of treated water utilized went to commercial, industrial, construction, fire protection, and governmental users and for system losses. The remaining 61 percent was used in residences.

Table 2-3 presents the annual quantity and percentage breakdown of the residential use of water by a typical family of four. About 40 percent of the treated water used by the typical family was for yard irrigation.

The pattern of treated-water usage varies throughout the year. Table 2-4 displays the quantity and percentage of treated water used by month.

TABLE 2-3

QUANTITY AND PERCENTAGE OF RESIDENTIAL WATER USED FOR DIFFERENT PURPOSES BY A FAMILY OF FOUR

Use	Annual Quantity of Water Used (in 1000 Gallons)	Percentage
Irrigation	76	39.8
Toilet flushing	51	26.7
Bathing	34	17.8
Life functions	14	7.3
Cleaning and laundry	11	5.8
Miscellaneous	5	2.6
Total	191	100.0

Source: DWB 1974.

TABLE 2-4

QUANTITY OF TREATED WATER AND PERCENTAGE OF AVERAGE ANNUAL WATER SUPPLY USED BY MONTH

Month	Quantity of Treated Water Used (in Acre-feet) 1/	Percentage
January	8,000	4.7
February	7,300	4.3
March	9,000	5.3
April	11,600	6.8
May	17,700	10.4
June	22,000	12.9
July	25,400	14.9
August	24,900	14.6
September	16,400	9.6
October	11,400	6.7
November	8,500	5.0
December	8,200	4.8
Total	170,400	100.0

Source: DWB 1973

1/ Assuming an average annual consumption of 170,400 acre-feet (average annual water supply consumed for the period 1964-1973).

Wastewater Treatment Facilities

There are presently 15 wastewater treatment facilities discharging to the streams in the Denver metropolitan area. The major facilities and their 1975 flows are shown by Table 2-5. In addition, Table 2-5 shows the existing capacity of the facilities and briefly summarizes the facility.

TABLE 2-5

MAJOR WASTEWATER FACILITY CAPACITY (MGD)

Facility	1977	Planned Expansion Amt-year	2000	Amt-Year
Englewood/Littleton	20.00	12.00-1984	32.00	-
South Lakewood	2.40	.10-1979 2/	2.50	-
MDSDD #1	170.00 4/	-	170.00	-
Sand Creek (Aurora)	1.50	16.50-1982 2/	18.00	-
South Adams County	2.40	1.90-1978	7.00	2.70-1987
Broomfield	3.60	-	3.60	-
Westminster	1.00	1.70-1978	-	8.30-1982 2/ 4.90-1990
Glendale	2.00	-	2.00	-
Morrison	.07	-	1/	-
Arvada	.90	-	.90	-
Denver	106.00 3/	-	106.00	-

1/ Plant to be connected to MDSDD #1 in 1978
2/ 201 study in progress
3/ Primary only - secondary treatment at MDSDD #1
4/ Includes 70 mgd primary and 170 mgd secondary capacity

As may be seen, MDSDD #1 provides nearly 85 percent of the wastewater treatment capacity. This facility is actually a joint facility with the Denver Northside (DNS) primary treatment facility which has a primary treatment capacity of 106 mgd. The DNS facility discharges to the MDSDD #1 facility primary effluent which is treated there to a secondary level before discharge to the South Platte River.

All wastewater discharged in the Denver area is presently being treated to a secondary treatment level as required by NPDES discharge permits. Several 201 facility planning studies are now ongoing to evaluate both increasing capacity and treatment levels in the area. These studies are being closely coordinated with the 208 Areawide Water Quality Study being conducted by the Denver Regional Council of Governments (DRCOG). This coordination, required by the state and the U.S. Environmental Protection Agency, has developed a process in which treatment capacity is scheduled in a timely fashion consistent with regional and local planning.

Generally, over the past two years significant improvement in the treatment of municipal wastewater has occurred. Basically, this has occurred through the addition of nearly 100 mgd in new treatment capacity in the metropolitan area. The 70 mgd expansion at the MDSDD #1 will give that facility the ability to discharge effluent 33 percent better than federal regulations which limit biological oxygen demand (BOD) to 30 ppm. The recently completed 208 clean water plan requires all municipal and industrial treatment plants or dischargers to meet the 1983 goals.

In addition, the major discharges of pollution from raw sewage because of inadequate interceptor capacity are being continuously eliminated. The Platte River II interceptor, which is nearing completion, will eliminate all of these raw sewage discharge points along the South Platte River. Only minor raw sewage discharge points, which discharge very infrequently under unique meteorological conditions, will continue in existence. Even relatively minor discharge points are being eliminated in the near future by facility improvements.

Law Enforcement

In 1977 the Denver area ratio of police personnel to population was above the generally accepted national standard of one sworn officer per 1,000 population. None of the six counties fell below the standard, and only one of the 26 municipalities in the area did not meet the standards. The mean for the area was one sworn officer per 529 population (DRCOG 1977).

The city and county of Denver had 1,375 sworn officers equalling 1 officer per 384 population. The range for municipalities in the area was from 1 officer per 287 population in Greenwood Village to 1 officer per 1,300 in Erie. Among the counties, Boulder had the highest standard--1 officer per 322 population. The range was from 1 officer per 322 to 1 officer per 758 in Douglas County with the median being Jefferson's 1 officer per 598 of population (DRCOG 1977).

In 1977, within the six-county area, there were 3,079 sworn officers--44.6 percent in the city and county of Denver, 33.6 percent in the other municipalities, and 14.6 percent in the five remaining counties. The Colorado State Patrol had 7.2 percent of the total distributed throughout the six-county area (DRCOG 1977).

Fire Protection

DRCOG gathered data on fire departments in the Denver area. It found that there were 22 fire departments with 1,919 personnel, including uniformed civilians and volunteers, which had 209 pieces of equipment in 87 stations, including one station at Stapleton Airport.

A most meaningful datum from the survey was the Town-Index fire-hazard rating of the various political subdivisions in the area. The Insurance Services Office use a 10-point scale (Table 2-6) to rate municipal fire protection. No city in the United States presently has a rating of 1. Denver is one of three cities in the country that has a rating of 2, meaning that people residing within the Denver County boundaries have the best available fire protection in the United States today. But, the median rating for the 22 fire departments in the area was 7, which means that, except for Denver and Aurora, fire protection in the area is below the quality which the fire Insurance Services Office of Colorado-Wyoming consider desirable.

TABLE 2-6

FIRE-HAZARD RATINGS FOR POLITICAL ENTITIES

Rating 1/	Percent of Total Fire Protection Index 2/
1	100
2	88.9
3	77.8
4	66.7
5	55.6
6	44.5
7	33.4
8	22.3
9	11.2
10	0

Source: Town-Index; Colorado-Wyoming September 1975; Insurance Services Office of Colorado-Wyoming, Denver, Colorado.

1/ A rating of "1" is perfect fire protection. A rating of "10" is no fire protection.

2/ The fire systems were rated according to four variables: (a) 39% for the fire department itself; (b) 39% for the water supply; (c) 13% for the fire safety control, regulations, ordinances, enforcements, etc.; and (d) 9% for the communication system.

WATER RESOURCES

The proposed Foothills Project would be located in the South Platte River watershed southwest of Denver. Raw water would be diverted from the South Platte River at the proposed Strontia Springs Diversion Dam. This water derives from two sources--the South Platte River drainage east of the Continental Divide and the Blue River drainage west of the Continental Divide. Map 1-9 depicts the existing sources of DWB raw water.

Present Raw Water Supply Systems

Present raw water supply is derived from the following sources.

Moffat System

The Moffat System collects and transports water from the upper Williams Fork Basin and the Fraser-Winter Park areas of the west slope via the Gumlick, Vasquez, and Moffat Tunnels to the east slope. In addition, some east slope water from South Boulder Creek and Ralston Creek is diverted for use in the system. It is stored in Gross and Ralston Reservoirs and from there is transported through pipelines and canals to the DWB and raw water users.

The Moffat Treatment Plant has a capacity to treat 210 mgd. The collection and storage facilities of the Moffat System provide raw water to DWB raw water contractors and the Moffat Treatment Plant. The potential exists to expand the Williams Fork collection system and enlarge the storage capacity of Gross Reservoir.

The Moffat System collects, stores, and diverts waters which originate in the west slope watershed of the Williams Fork and Fraser Rivers and the east slope watersheds of South Boulder and Ralston Creeks. Such waters may be stored in Gross Reservoir (capacity 43,065 acre-feet) and Ralston Reservoir (capacity 11,272 acre-feet) before delivery to the raw water users and the Moffat Treatment Plant. Table 2-7 summarizes data obtained from DWB annual reports.

Average annual flow of the Williams Fork River near Leal, Colorado (a named USGS gaging station), downstream of the confluence of the South Fork of the Williams Fork and Williams Fork, was 69,000 acre-feet during the period 1964-1973 after DWB Williams Fork diversions. The capacity of Williams Fork Reservoir is nearly 97,000 acre-feet. During the period 1969 to 1973, it supplied about 43,000 acre-feet on an average annual basis for exchange and replacement.

TABLE 2-7

MOFFAT SYSTEM WATER SOURCES AND USE
(ACRE-FEET)

Year	Williams Fork River	Fraser River	So. Boulder & Ralston Creeks	Raw Water Deliveries, Operating Losses, etc. 1/	Moffat Treatment Plant
1964-73 (Average)	4,900	47,900	11,500	11,800	52,500
1974	4,400	64,200	7,800	9,100	67,300
1975	5,800	55,600 2/	14,100	17,000	58,500

1/ The sum of Williams Fork River, Fraser River, South Boulder and Ralston Creeks less Moffat Treatment Plant represents raw water deliveries, operating losses, and storage changes.

2/ Includes Cabin-Meadow Creek System placed in service May 12, 1975.

Average annual flows of the Fraser River and several of its tributaries at locations downstream of the DWB diversion points for the 10-year period are as follows:

Fraser River near Winter Park	13,200 acre-feet
Vasquez Creek near Winter Park	9,400
St. Louis Creek near Fraser	14,800
Ranch Creek near Fraser	7,900
Total	45,300 acre-feet

These are the flows remaining after DWB diversions. The average annual supply diverted from the west slope during 1964-1973 via the Moffat Tunnel into the South Boulder Creek watershed was 52,800 acre-feet.

Downstream of the DWB South Boulder Diversion Intake Dam, the average annual flow of South Boulder Creek near Eldorado Springs, Colorado, was 46,100 acre-feet from 1964 to 1973 after the storage, regulation and diversion of the west slope and native South Boulder Creek waters by the DWB.

None of the raw waters available from the DWB Moffat System can be provided directly for treatment at the proposed Foothills plant.

Roberts Tunnel System

The Roberts Tunnel System collects and stores west slope waters from the Blue River, Tenmile Creek, and Snake River, which are stored in Dillon Reservoir and diverted through the Roberts Tunnel, flowing down the North Fork of the South Platte River and then down the South Platte River to Marston and Kassler Treatment Plant Intakes. Roberts Tunnel imports from the west slope began in 1964. With the introduction of Dillon Reservoir water into the channel of the North Fork, channel stabilization work was conducted by the DWB, principally along a 12.8-mile reach from the outlet portal of the Roberts Tunnel to a location about 1 mile downstream of Bailey, Colorado. Future raw water supplies that potentially could be added to the present Roberts Tunnel supplies include additional Blue River watershed diversions and Eagle River, Gore Creek and Colorado River diversions west of Vail Pass.

South Platte System

The South Platte System collects, stores, and diverts east slope water from the South Platte River watershed. Storage in this system is provided by Antero, Eleven Mile, and Cheesman Reservoirs. Water is

treated at the Marston and Kassler Treatment Plants. The Kassler Treatment Plant has a capacity of 50 mgd. The Marston Treatment Plant has a capacity of 260 mgd. The conduit from the Platte Canyon Intake has a capacity of 210 mgd. Additional raw water supplies from the South Platte River may be derived from additional storage on the South Platte River; exchange of sewage effluent may be derived from transmountain water with downstream water users and acquisition of water rights.

Downstream, within the Denver metropolitan area along the South Platte River, are eleven diversions (Table 2-8). The DWB and the city of Englewood own the dominant portion of the water rights associated with these facilities.

The cities of Aurora and Colorado Springs jointly own the Homestake Project. Homestake Project water originates west of the Continental Divide in the Eagle River watershed. The water is stored in Homestake and Turquoise Lakes in the upper Arkansas River watershed and released to the Arkansas River near its confluence with Clear Creek. A conduit carries the water eastward to a point where the Aurora share of the water is conveyed to Eleven Mile Canyon Reservoir and the South Platte River. The remaining portion continues on to Colorado Springs. The city of Aurora's water flows down the South Platte River to the existing Aurora Intake, where the water is diverted to Rampart Reservoir. The city of Aurora can divert up to 140 mgd (216 cfs) with its intake. The existing intake would be inundated by the proposed Strontia Springs Diversion Dam and Reservoir. A new intake structure for the city of Aurora is included in the plan described in the discussion of project components.

The DWB also diverts raw water from Bear Creek at the Bear Creek Diversion Dam near Morrison, Colorado. The water is conveyed to Marston Lake by the Harriman Canal. The DWB also shares ownership of Soda Lakes (DWB capacity, 660 acre-feet). Water obtained from Soda Lakes is conveyed to Marston Lake by the Harriman Canal or exchanged to the South Platte Intake structure.

Clear Creek flows into the South Platte River north of the city of Denver and services primarily downstream water rights outside of the metropolitan area. The Public Service Company receives part of its nearly 97,000 acre-feet. During the period from 1969 to 1973, it supplied about 43,000 acre-feet on an average annual basis for exchange and replacement.

Developed from simulated operation of the DWB system, the average annual raw water supply for the 1947-1965 period was as follows (Table 2-9):

TABLE 2-8

SOUTH PLATTE RIVER DIVERSIONS BELOW THE PROPOSED STRONTIA SPRINGS DAM SITE

Diversion Name	Ownership	Water Use 1/
Highline Canal	DWB	Municipal, industrial, irrigation
Flume to Kassler fillers	DWB	Municipal, industrial
Last Chance	DWB (partial)	Municipal, industrial, irrigation
City Ditch (out of Chatfield Dam and Reservoir) 2/	DWB City of Englewood	Irrigation City Park Use
McClelland Reservoir pump station	City of Englewood	Municipal, industrial
Brown Ditch	City of Englewood	Municipal, industrial, irrigation
	DWB	Future municipal and industrial
Petersburg Ditch	City of Englewood	Municipal, industrial
Public Service Company	DWB 3/	Arapahoe Power Plant
Epperson Ditch	City of Englewood DWB	None Golf course irrigation
Farmers & Gardeners	DWB 3/	Cherokee Power Plant
Nevada (out of Chatfield Reservoir)	DWB, City of Englewood, and others 2/	Municipal, industrial, irrigation

1/ User by each entity under "Ownership" column.

2/ Chatfield Dam and Reservoir does not store the water for the water owners. Provisions are designed into the facility to accommodate continual flow-through into the river system.

3/ The DWB owns the water and sells it to Public Service Company for power plant operations.

TABLE 2-9

AVERAGE ANNUAL WATER SUPPLY

Moffat System	92,000 acre-feet	29%
Roberts Tunnel System	124,000 acre-feet	40%
South Platte System	96,300 acre-feet 1/	31%
Totals	312,300 acre-feet 2/	100%

1/ Includes 14,300 acre-feet from Bear Creek and South Platte River ditches.

2/ Does not include operating losses.

From Table 2-10 it can be seen that the availability and location of the supply in the respective collection and storage systems varies.

Factors in this variation are the availability and location of supply in the respective collection and storage systems, the annual demand for treated and raw water, and operational constraints imposed by maintenance or construction.

Water Rights

Under the laws of the State of Colorado, the DWB has obtained water rights which enable it to divert, store, and redivert raw water from east slope and west slope watersheds for ultimate consumption within the DWB service area. The operation of the DWB raw water system under such rights involves the coordinated operation of numerous collection, storage, conveyance, and diversion facilities to supply raw water to intakes of existing treatment plants--Kassler (50 mgd), Marston (260 mgd), Moffat (210 mgd)--and to raw water users. Use of different sources of water varies with hydrologic and climatic conditions, available reservoir storage, and demand for raw and treated water.

Flows and Reservoir Levels

A summary description of the watersheds from which the DWB obtains its raw water supplies follows. The discussion will address two of the three principal segments of the DWB system: the Roberts Tunnel System and the South Platte System. Although the third segment, the Moffat System, is coordinated with the others so that they all operate as one integrated whole, it is omitted from this discussion because it is not impacted by the proposal.

TABLE 2-10

RAW WATER USE BY DWB AND ITS RAW WATER CONTRACTORS

System	1964-1973 Average	1974	1975
Moffat System	64,300 acre-feet (31%)	76,400 acre-feet (29%)	75,500 acre-feet (31%)
Roberts Tunnel System	29,600 acre-feet (15%)	42,710 acre-feet (17%)	46,400 acre-feet (19%)
South Platte System	111,400 acre-feet (54%)	140,200 acre-feet (54%)	122,800 acre-feet (50%)
Totals	205,300 acre-feet (100%)	259,300 acre-feet(100%)	244,700 acre-feet(100%)

Source: DWB Annual Reports, which include operating losses

Raw water provided the DWB service area from the coordinated operation of the DWB system during the period 1964-1973 averaged 205,300 acre-feet per year. In 1974 and 1975 the total raw water provided was 259,300 and 244,700 acre-feet respectively. Raw water that was treated by the DWB averaged 170,400 acre-feet annually during the 10-year period; it was 221,300 and 208,000 acre-feet, respectively, in 1974 and 1975. The balance was provided to raw water users and absorbed as operating losses (DWB annual reports).

Roberts Tunnel System

The Roberts Tunnel System consists of Dillon Dam and Reservoir (capacity 254,036 acre-feet at 9,017 feet elevation) and the Harold D. Roberts Tunnel (maximum capacity 1,000 cubic feet per second (cfs)). Water from the Blue River was first diverted through the Roberts Tunnel in October 1963.

Runoff of the Blue River has been stored in Dillon Reservoir primarily during the months of May and June when spring runoff is at its peak. Monthly diversions of water through the Roberts Tunnel to the North Fork of the South Platte River have generally been largest during July and August, coinciding with the period of greatest demand for water within the DWB service area.

Inflow to Dillon Reservoir for the period 1964-1973 averaged 187,500 acre-feet annually (not including unmeasured flow). The average annual release from Roberts Tunnel for 1964-1973 was 29,600 acre-feet. Table 2-11 presents the historical average monthly discharge of the Roberts Tunnel. Instantaneous (short-duration) flows from the Roberts Tunnel have varied from zero discharge on many occasions to 433 cfs during the period August 11 through 20, 1976. Releases made during the period August 18 through 28, 1974, which were relatively steady at 343 cfs, are more typical. The maximum annual diversion of water from Dillon Reservoir through the Roberts Tunnel was 50,400 acre-feet in 1967 (including tunnel seepage).

The content of Dillon Reservoir since the initial filling in 1965 has exceeded 200,000 acre-feet every year through 1973 (Table 2-12). It has been full (254,000 acre-feet) 20 percent of the time. The maximum drawdown of record was 17.7 feet below full storage in April 1967. The average maximum annual drawdown of the reservoir during the period from 1964 to 1973 was about 10 feet.

Dillon Reservoir at full capacity (9,017 feet elevation) has a water surface area of 3,233 acres. During the 8-year period from 1966 to 1973, the surface area reduction each year averaged 394 acres (Table 2-12).

TABLE 2-11

HISTORICAL MONTHLY AVERAGE DISCHARGE FROM THE ROBERTS TUNNEL, THE NORTH FORK OF THE SOUTH PLATTE RIVER AND THE SOUTH PLATTE FOR THE PERIOD 1964-1973 (in cfs)

Month	Roberts Tunnel Diversions	North Fork South Platte at Grant 1/	North Fork South Platte at South Platte 1/	South Platte River below South Platte 1/	South Platte River at Waterton
(1)	(2)	(3)	(4)	(5)	(6)
January	22	39	67	134	27
February	17	32	58	123	19
March	20	38	69	149	18
April	37	63	127	332	145
May	26	148	375	900	643
June	14	255	490	910	550
July	74	230	362	762	403
August	141	226	348	664	325
September	66	113	182	377	134
October	27	65	123	238	86
November	19	48	93	184	65
December	24	46	73	143	31
Average Annual	41	109	198	412	205
Acre-feet	29,600	79,000	143,500	298,000	148,400

1/ Includes historical Roberts Tunnel diversions.

TABLE 2-12

HISTORICAL ANNUAL MAXIMUM DRAWDOWN OF DILLON RESERVOIR AFTER INITIAL FILLING IN 1965

Year	Minimum EOM 1/ Content During Year (acre-feet)	Month of Minimum Content	Number of Feet below Full Elevation (9,017)	Surface Acres Reduced
1966	221,600	December	10.6	385
1967	202,200	April	17.7	593
1968	222,000	May	10.5	588
1969	224,600	April	9.6	353
1970	238,600	March	4.9	195
1971	236,100	October December	5.7	228
1972	220,100	December	11.2	404
1973	219,200	March	11.5	413
Mean	223,050		10.2	393.6

Source: USGS 1964-1973.

1/ End of month

Stipulations for the operation of Dillon Reservoir require release of natural inflow or 50 cfs, whichever is less, or small flows in times of water shortage.

The Blue River Decree provides that if in a given year, Green Mountain Reservoir does not fill from runoff originating downstream of Dillon Dam and from spills from Dillon Reservoir, the DWB must release the amount of water necessary to fill Green Mountain Reservoir from Dillon Reservoir. Such a release need not exceed the amount necessary to fill Green Mountain Reservoir, and it need not include amounts stored in previous years that might now be necessary to fill Green Mountain Reservoir. Dillon Reservoir was filling during 1964 and 1965. After it began normal operation, average annual flows in the Blue River downstream of Dillon Dam were 143,500 acre-feet during the 1964-1973 period.

Prior water rights downstream on the Colorado River must be recognized under Colorado water law by the DWB in its operation of the Roberts Tunnel and Moffat Systems' collection and storage facilities. The DWB either bypasses inflow to the Colorado River or provides exchange and replacement water to the Colorado River from DWB's Williams Fork Reservoir to compensate for retaining water elsewhere.

The Colorado River has discharged at the Colorado-Utah State line an average of 4,241,000 acre-feet per year during the period from 1964 to 1973. Approximately 51 percent of this flow occurred during the months of May, June, and July on the average. During May and June of 1973, when most of the storing of water in upstream reservoirs was occurring, the Colorado River discharged about 2,371,000 acre-feet, or about 44 percent of the total 1973 flow.

South Platte System

The South Platte River originates in the Rocky Mountains northwest of Fairplay, Colorado. The South Platte River upstream from the Denver metropolitan area is a scenic mountain stream with frequent pools, riffles and fast shallow reaches. After leaving the mountains southwest of Denver, it meanders across the plains of northeastern Colorado and flows into the State of Nebraska near Julesburg, Colorado, and subsequently joins the North Platte River near North Platte, Nebraska. The drainage area of the South Platte River at various locations is shown in Table 2-13, with the average annual flow for the period from 1964 to 1973.

DWB facilities on the South Platte River upstream of Waterton include Antero Reservoir (15,878 acre-feet), Eleven Mile Reservoir (97,779 acre-feet), Cheesman Reservoir (79,064 acre-feet), South Platte Intake Dam, and the Highline Canal Diversion Dam.

TABLE 2-13

SOUTH PLATTE RIVER DRAINAGE AREA AND AVERAGE ANNUAL RUNOFF, 1964-73 1/

Location	Drainage Area (square miles)	Average Annual Runoff (acre-feet)
SPR 3/ below Cheesman Dam	1,752	128,200
NFSPR 4/ at Grant	127	79,000 1/
NFSPR at South Platte	479	143,500 1/
SPR at South Platte	2,579	298,000 1/
SPR at Waterton	2,621	148,400
SPR below Denver	4,400 (approx.)	469,000 2/

1/ Includes historical Roberts Tunnel imports from Dillon Reservoir.
2/ Includes Clear Creek and sewage return flows. Does not reflect depletions by the Burlington pump and canal.
3/ SPR - South Platte River.
4/ NFSPR - North Fork of the South Platte River.

The existing natural flows of the South Platte River are augmented by transmountain diversions by the Aurora-Homestake Project, Boreas Pass Ditch, and Roberts Tunnel diversion from Dillon Reservoir. The DWB uses the natural flows of the South Platte River under its water rights either by direct diversion to use or by storage in the DWB reservoirs previously identified and the Platte Canyon (941 acre-feet) and Marston (17,213 acre-feet) Reservoirs.

The levels of flow in the South Platte River are dependent upon three factors: (1) natural runoff, (2) releases of stored water, and (3) transmountain diversions. Historical average monthly flows of the South Platte River at South Platte range from a low of 123 cfs in February to a high of 910 cfs in June (Table 2-11). Instantaneous flows higher than those shown in Table 2-11 have occurred, as shown in Table 2-14.

Natural runoff from melting snow accounts for most of the flow in May and June. High flows are sustained throughout July and August by releases of stored water and transmountain diversions. The average annual flow at various locations on the South Platte River and the North Fork of the South Platte River are shown in Table 2-13. Estimated frequency of flood peaks and volumes for the South Platte River at South Platte are presented in Table 2-15.

TABLE 2-14

SOUTH PLATTE RIVER (SPR) HISTORICAL DISCHARGE EXTREMES IN CFS

Location	Minimum	Date	Maximum	Date
SPR below Cheesman	1.6	4/8-14/57	4,640	4/29/70
At South Platte	10.0	12/5/1899	6,320	6/8/21
At Waterton	0.1	3/6-7/33 2/28-3/2/38 3/20/38	5,700	4/23/42

TABLE 2-15

ESTIMATED FREQUENCIES OF FLOOD PEAKS AND RUNOFF VOLUMES
FOR THE SOUTH PLATTE RIVER AT SOUTH PLATTE, COLORADO, 1902-1971

Recurrence Interval (Years)	Peak Discharge (cfs)	Flood Volume (acre-feet)			
		1-Day	3-Day	7-Day	20-Day
2	1,440	2,530	7,250	15,400	39,200
5	2,380	4,360	12,200	25,900	65,500
10	3,190	5,960	16,700	35,600	87,500
25	4,440	8,350	23,600	50,100	118,800
50	5,540	10,550	29,700	63,200	144,500
100	6,800	12,770	36,400	77,600	173,300

Source: DWB 1973

The average annual flow of the South Platte River at South Platte during the 1964-1973 period was 298,000 acre-feet, including an average of 29,600 acre-feet of Roberts Tunnel System water. The DWB diverted about 117,700 acre-feet annually, including Blue River water, to meet demands for treated water at Kassler and Marston.

In addition, about 5,300 acre-feet of Homestake Project water (Aurora) and 300 acre-feet of Boreas Pass water (Englewood) is included in the South Platte River in the South Platte average annual flow during 1964 to 1973. The Aurora-Homestake Project water is diverted at a location just upstream of the proposed Strontia Springs dam site to Aurora's Rampart Reservoir. The Englewood-Boreas Pass Ditch water is diverted from the South Platte River downstream of Chatfield Dam for treatment and use by that community.

A principal tributary of the South Platte River upstream of the proposed Strontia Springs dam site is the North Fork of the South Platte River. This tributary originates on the south slope of Mount Evans. From the east portal of Roberts Tunnel near Grant, Colorado, the stream flows approximately 33 miles before joining the South Platte River near South Platte about 4.8 miles upstream from the proposed dam site and 24 miles downstream of Cheesman Dam.

The levels of flow in the North Fork of the South Platte River are dependent upon two factors: (1) natural runoff and (2) Roberts Tunnel diversions from Dillon Reservoir. Like the South Platte River, the North Fork experiences its lowest average monthly flows in February (58 cfs) and highest average monthly flows in June (490 cfs). High flows in May and June are primarily the result of snowmelt runoff. Relatively high flow levels are sustained through July and August by Roberts Tunnel diversions (Table 2-11).

The average annual flow of the North Fork of the South Platte River at Grant was 79,000 acre-feet and at South Platte was 143,500 acre-feet during 1964-1973 (Table 2-11). The maximum instantaneous flow on the North Fork of the South Platte River at Grant was 990 cfs on June 7 and 8, 1912, and at South Platte it was 2,050 cfs on June 13, 1949. The largest release from the Roberts Tunnel of 433 cfs occurred during August 1976 and was maintained over a 10-day period.

Following completion of the Roberts Tunnel and Dillon Dam, the DWB essentially completed channel stabilization work along the 12.8-mile reach of the North Fork of the South Platte River between the east portal of the Roberts Tunnel and Bailey, Colorado. The design provided for the capability of sustaining flows of up to 680 cfs. The channel was designed for a peak discharge of 1,020 cfs at the beginning of the reach (Ecological Analysts, Inc. 1974). The additional channel capacity (a safety factor of about 50 percent) was provided for the anticipated, but infrequent, short-lived periods when capability to pass flows of up to 1,020 cfs is required. Channel stabilization work in the lower reach of the North Fork is to occur as it becomes necessary.

Types of works completed include control and check structures, bypass channels and relief conduits (to reduce flows in natural channels), channel riprapping where necessary and streambank revegetation.

Ground Water

Mountain ground water is usually a function of joint or fracture, density, and the degree of weathering along such openings. In a general way, the ground water table follows the contours of the land surface at shallower grades. The water table approaches the surface in the canyon bottom but is considerably deeper under the canyon walls (Board of Water Commissioners, Vol. II, 1973). Water seepage into rock fissures can be significant. Tests conducted by the DWB describe the capacity of fissures to pass water at various points of the canyon.

Standing water was not observed in any drill holes at the proposed treatment plant site. The soils and bedrock of the area are a mixture of clays and sandstone developed on the Pierre shale formation. The proposed treatment plant location is at the ground water recharge area of the outcropping sedimentary beds. The Pierre formation is known as a poor aquifer, probably because of the high clay content and resulting poor permeability. Ground water levels in the formation would be low and relatively immobile. The water table would be encountered only at some increased depth, and when encountered would not allow water to move through it, as would a more porous aquifer such as the Fox Hills sandstone formation.

Water Quality

The chemical content of instream water varies greatly and is a reflection of local geography and climate and any pollution sources which may discharge to the stream. Minerals have different solubilities, and various forms of aquatic life change the form of many dissolved substances. For 8 years, the DWB has sampled water quality, at two locations pertinent to the proposed project.

The first location is at the South Platte River Intake at Kassler and the second is at the outlet of the Roberts Tunnel. The data are reflected in Tables 2-16 and 2-17, respectively. This is the only known data available.

Water hardness and alkalinity were moderate in the study area; this is higher than normal for such streams. Nitrate exhibited normal trace amounts. Trace amounts of orthophosphate were higher than expected (DWB 1974).

TABLE 2-16

RAW WATER QUALITY FOR THE SOUTH PLATTE RIVER AT PLATTE CANYON INTAKE

Variable 1/	Maximum	Minimum	Average	No. of Analyses
Water temperature (deg. C)	22	0	9	--- 2/
Turbidity (JTU) 4/	70	1.5	8	--- 2/
Conductivity (micromhos/em)	455	155	315	9
pH (S.U.) 5/	8	7.7	7.8	9
Total alkalinity	112	48	84.8	9
Total solids	285	92	183.5	6
Nitrate	0.15	0.02	0.07	5
Phosphate	0.11	0.03	0.06	7
Total hardness	162	62	118	11
Calcium	40.0	16.4	29.8	12
Magnesium	16.0	5.0	10.0	12
Sodium	34.6	18.4	26.0	7
Chloride	51.0	8.5	30.0	12
Sulfate	75.6	15.0	43.6	10
Fluoride	1.41	0.88	1.10	10
Iron	0.84	0.05	0.35	9
Manganese	0.15	0.01	0.05	9
Plankton (plankton/ml)	922	44	344	--- 3/

Source: DWB 1974

1/ Units are in milligrams per liter, except as noted otherwise.
2/ Temperature and turbidity have been obtained from daily records of Kassler Treatment Plant, August 1963 to May 1971.
3/ Plankton counts are average monthly figures of the Platte Canyon Reservoir for 1972 with diatomaceae as the most numerous species, followed by protozoa and chlorophyceae.
4/ Jackson Turbidity Units.
5/ Standard Units.

TABLE 2-17

RAW WATER QUALITY FOR DILLON RESERVOIR AT OUTLET

Variable 1/	Maximum	Minimum	Average	No. of Analyses
Water temperature (deg. C)	15	1	6.3	14
Turbidity (FTU) 2/	3.0	0.0	1.1	12
Conductivity (micromhos/cm)	310	100	166	15
pH (S.U.) 3/	8.0	7.1	7.5	17
Total alkalinity	96	30	56	17
Total solids	178	26	120	9
Nitrate	0.55	0	0.16	10
Phosphate	0.30	0	0.16	12
Total hardness	90	55	74	17
Calcium	29.2	16.0	21.3	18
Magnesium	7.3	2.3	5.0	18
Sodium	10.6	2.7	4.5	9
Chloride	20.0	0.2	5.5	16
Sulfate	52.0	15.6	32.0	15
Fluoride	0.84	0.35	0.52	13
Iron	0.24	0	0.09	12
Manganese	0.29	0	0.07	11
Plankton (plankton/ml)	----------------Not available----------			

1/ Units are in milligrams per liter, except as noted otherwise.
2/ Florescent Turbidity Units.
3/ Standard Units.

Public health standards are given in Table 1-8. The following factors affecting the quality of water occurred in the above areas in lower concentrations than recommended by public health standards: turbidity, total dissolved solids, nitrate, phosphate, chloride, sulfate, flouride, iron and manganese.

Water quality in the South Platte River as it flows through Denver was sampled and analyzed during the DRCOG 208 Clean Water Project. Based on that analysis, the treatment level and capacities of facilities needed to meet 1983 water quality goals were determined. See Table 2-5.

It is anticipated that capacities and treatment levels will keep pace with population growth since it is required by the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500). Violators are subject to heavy fines.

The South Platte River through Denver is presently classified as a B-2, secondary contact recreation warm water stream. Standards related to this classification are shown in Table 2-18. It should be noted that the quality of water in the South Platte River is affected by flow from its tributaries such as Bear, Clear, Sand and Cherry Creeks and by overland flows along its length as well as by direct discharges into its waters.

The major water quality problem in the South Platte through Denver, for the foreseeable future, is the impact of runoff from nonpoint sources. The 208 study found that runoff will cause the South Platte to be polluted even though point sources are adequately controlled. At this time, however, substantial new data are needed to identify and quantify pollution from particular sources so that suitable remedial measures can be taken. The continuing 208 planning program is expected to focus on nonpoint sources. Lawn irrigation does contribute to runoff-caused pollution, but it is not clear that cutting it back or stopping lawn irrigation altogether will substantially modify the instream water quality.

Present modified condition salinity concentrations of the Colorado River at Cameo, Colorado, and Imperial Dam, Arizona, (Bureau of Reclamation (BR) 1977) are 440 mg/l and 861 mg/l, respectively.

TABLE 2-18

WATER QUALITY STANDARDS FOR THE SOUTH PLATTE RIVER
A B-2 COLD WATER STREAM

Standard	River Status
Settleable solids	Free from
Floating solids	Free from
Taste, odor, color	Free from
Toxic materials	Free from
Oil and grease	Cause a film or other discoloration
Radioactive material	Drinking water standards
Fecal coliform bacteria	Geometric mean of 1000/100 ml, 5 samples/30 days
Turbidity	No increase of more than 10 JTU
Dissolved Oxygen	6 mg/l minimum
pH (S.U.) 1/	6.0 - 9.0
Temperature	Maximum 60 degrees F. Maximum change 2 degrees

Source: Colorado Department of Health, Water Quality Control Division 1974.

1/ Standard Units.

In the Foothills Project area, the important aquatic habitats are located on the South Platte River.

Fish Populations

The South Platte River is well known as a productive trout stream. A comprehensive study of the fish population and bottom fauna was included as part of the environmental assessment of Waterton Canyon prepared for the DWB. The 9.7-mile study section was divided into three major, easily defined study areas (see Map 2-1 located at the end of this chapter) (DWB 1974). A description of them follows.

1. That portion of the river extending from the confluence of the South Platte and its North Fork to the Platte Canyon Intake Dam is a fast-flowing stream with an abundance of cover in the form of large boulders, some overhanging vegetation, and swift riffle areas.

2. That portion of the river extending from the Platte Canyon Intake Dam to the Highline Canal Diversion Dam suffers from water withdrawal. Sand siltation, dredging operations, and the consequent destruction of prime aquatic habitat. Former road building encroachment has further changed the river ecology to a somewhat undesirable and unproductive level.

3. That portion of the river extending from the Highline Canal Diversion Dam to the Kassler Treatment Plant suffers from severe habitat destruction because of extreme water withdrawal, sand siltation, and earlier channelization or ditching.

Fish species found in the study area include rainbow trout, brown trout, and several species of non-sport fishes. Table 2-19 presents a summary of these fish species. There are no endangered species of fish known to inhabit the South Platte River.

Despite the various disturbances to the aquatic environment of Waterton Canyon, the river is still a very productive sports fishery (Table 2-20). Under present conditions, trout are able to migrate up and down the river to select the best possible spawning site. No information is available concerning the extent of this movement or to what degree it is essential for perpetuating fish populations. Diversion dams not only curtail fish migrations but also further degrade their habitat by reducing flows and releasing accumulation of sediment. The river appears to be supporting a good population of brown and rainbow trout comparable to or exceeding other well known waters in Colorado (Table 2-21).

TABLE 2-19

FISH SPECIES IN THE WATERTON CANYON

Common Name	Scientific Name
Rainbow trout	Salmo gairdneri
Brown trout	Salmo trutta
Stoneroller	Campostoma anonalum
Longnose sucker	Catostomus catostomus
White sucker	Catostomus commersoni
River shiner	Notropis blennius
Bigmouth shiner	Notropis blennius
Sanshiner	Notropis blennius
Fathead minnow	Pimephales promelas
Longnose dace	Rhinicthys cataractae
Creek chub	Semotilus atromaculatus

Source: DWB, Environmental Assessment, 1974.

TABLE 2-20

POPULATION ESTIMATE FOR BROWN AND RAINBOW TROUT IN THE WATERTON CANYON FOR SUMMER AND FALL, 1973

Study Section and Trout Species	Population Estimate	Population Estimate for Total Area 1/	Number of Fish per Surface Area	Pounds of Fish per Surface Area
1. Brown	157	10,833	319	52
Rainbow	27	1,863	55	12
Total		12,696	374	64
2. Brown	136	2,441	276	43
Rainbow	76	1,368	154	35
Total		3,809	430	78
3. Brown	77	1,217	156	37
Rainbow	----No Estimate ----------			
Total		1,217	156	37

Source: DWB, Environmental Assessment, 1974.

1/ Estimates are based on backpack electrofishing of 500-foot study sections and using the Peterson mark-recapture index for population estimates.

TABLE 2-21

POPULATIONS OF BROWN AND RAINBOW TROUT
IN THE LOWER SOUTH PLATTE RIVER
AS COMPARED WITH POPULATION OF OTHER WATERS (1974)

Location in Colorado	No. of Fish per Acre	Pounds of Fish per Acre	Reference
Lower South Platte River 1/	350 @ .2 lb.	71.3	DWB, Environmental Assessment, 1974, Appendix A, p. A-15
Upper South Platte River 2/	360 @ .17 lb.	61.4	U.S. Department of the Interior F&WS 1975a, p. 13
Cache la Poudre River 3/	215 @ .30 lb.	65.0	Colorado Department of Natural Resources, 1974b
Frying Pan River	156 @ .83 lb.	128.9	Colorado Department of Natural Resources, 1974a
Roaring Fork River	340 @ .8 lb.	271.0	Colorado Department of Natural Resources, 1972
Big Thompson River	744 @ .16 lb.	120.3	U.S. Department of the Interior, F&WS, 1972

1/ This location is downstream from the confluence with the North Fork of the South Platte.

2/ This location is upstream of the confluence with the North Fork of the South Platte.

3/ These data include only trout six inches long, or greater.

Bottom Fauna

The bottom fauna sampling from the three sites (upstream of, within, and downstream from the proposed reservoir) revealed eight major groups of organisms (Table 2-22); mayflies, stoneflies, and caddisflies constituted 79 percent of the total species.

The three dominant orders found in each stream are very often restricted to the clean water environment and compose a large portion of the organism in any such environment (Ganfin 1973).

Aquatic Vegetation

Flowering plants (aquatic angiosperms) are not known to occur in the proposed project area of the South Platte River. The scouring action of the water and sand prevents these rooted aquatic plants from becoming established.

Amphibians

Amphibians are known to breed in temporary ponds along the existing road in the lower reaches of the canyon. Table 2-23 presents a species checklist of amphibians found in Douglas and Jefferson Counties and a notation of species found in or near the proposed project area. Map 2-1 shows the locations of the four known amphibian ponds.

TABLE 2-22

MEAN NUMBER OF ORGANISMS PER SQUARE METER
SOUTH PLATTE RIVER, MARCH 15, 1973 TO MAY 17, 1973

Common Name	Order	Number at Site 1	Number at Site 2	Number at Site 3
Mayfly	Ephemeroptera	400	281	396
Stonefly	Plecoptera	62	38	41
Caddisfly	Trichoptera	145	142	233
True Fly	Diptera	78	79	157
Beetle	Coleoptera	20	22	48
Dragonfly	Odonata	-	3	3
Segmented worm	Annelida	3	26	12
	Mematomorpha	-	2	2

Source: Ward 1974.

TABLE 2-23

AMPHIBIANS FOUND IN JEFFERSON AND DOUGLAS COUNTIES

Common Name		Scientific Name
Barred Tiger Salamander	Caudata:	Ambystoma tigrinum mavortium
Rocky Mountain Toad 1/	Anura:	Bufo woodhousei woodhousei
Boreal Chorus Frog		Pseudacris triseriata maculata
Bullfrog		Rana catesbeiana
Western Leopard Frog 1/		Rana pipiens brachycephala
Plains Spadefoot 1/		Spea bombifrons

Source: Smith, H.M. et al 1965, for DWB 1974.

1/ The Rocky Mountain Toad (Bufo woodhousei woodhousei) and the Western Leopard Frog (Rana pipiens brachycephala) are found in the lower canyon, not in the study site. Both use temporary ponds along the canyon, below the study site, as breeding sites.

GEOLOGY, MINERALS, AND TOPOGRAPHY

Topography and General Geology

In the proposed Foothills Project area, the South Platte River flows across two distinctly different geologic provinces which are regions with grossly similar geology. The South Platte River flows from its source along the Contienental Divide in the Mosquito Range and then flows eastward toward Denver crossing sedimentary rocks. From the head of the river to Kassler, the river flows across crystalline igneous and metamorphic rocks of the southern Rocky Mountain physiographic province (Fenneman 1931). From Kassler through Denver and beyond, the South Platte flows across the flat-lying sediments of the Great Plains province (Fenneman 1931).

Alluvium is sparse within the Waterton Canyon with the narrow deposits along the canyon floor. Alluvium deposits as much as 20 feet thick, composed predominantly of pebbles and cobbles derived from local rock, occur in the canyon (U.S. Geological Survey (USGS) 1964).

Near the east end of the Waterton Canyon, the river passes from crystalline terrain to sedimentary rocks. Along the eastern flank of the mountains, these rocks are warped upward to form hogback ridges. These landforms are breached by the river as it crosses onto the Great Plains physiographic province. The geology of the area is thoroughly described in several works listed in the bibliography (USGS 1963a, 1963b, 1964c).

Geologic Processes

The South Platte river carries a streamload equal to 70,000 tons (36 acre-feet) of sediment annually past any given point in the Waterton Canyon. The streamload is the solid material actually transported by a stream, either as visible sediment (carried in suspension or moved along the streambed by saltation and traction) or in chemical or colloidal solution (Gary and Wolf 1972). Any time the velocity of a stream carrying its optimum load of sediment diminishes, a portion of that load settles out (Krynine and Judd 1957). Under natural conditions, this process is continually taking place; material is picked up as rapid flow increases the stream's capacity to hold sediment and is deposited where eddies or natural obstructions slow the flow of the stream. When rapidly flowing river water enters a reservoir, its velocity decreases, causing sediment to settle out. As sediment continues to be deposited, it displaces water in the reservoir until there is little storage space for water remaining behind the dam.

In addition, this capture of sediment by the reservoir removes material that otherwise would be carried downstream and deposited elsewhere. Thus, water flowing downstream of the dam contains much less than its optimum load of sediment. In reaches of the river below the dam, there is an increase in bank erosion as the river again acquires its optimum load of sediment. Before it acquires its optimum load again, it is in a condition of streamload imbalance.

Presently, there are two structures in the Platte Canyon that cause a streamload imbalance in the river. These are the Platte Canyon Intake Dam and the Highline Canal Diversion Dam. To offset the imbalance, and also to allow continued operations, the Platte Canyon Intake Dam is periodically flushed and the Highline Canal Diversion Dam is draglined to remove accumulated sediments (DWB 1974).

Minerals

Anomalies of radium and radon concentrations in spring water issuing from faults in Stevens Gulch (N½, Sec. 21, T.7 S, R. 69 W.) suggest slight concentrations of uranium (USGS 1963b). Although no deposits have actually been discovered within the project area, the presence of uranium can also be inferred geologically.

In the area near the treatment plant site, limestone, sand and clay have been quarried. At present, although no operations are active, a quarry in the SE½, Sec. 2, T. 17 S, R 69 W., from which "quite pure" limestone was mined, operated on at least a part-time basis in 1963 (USGS 1963b).

Geologic Hazards and Problem Areas

Faults, Joints, Seismic Activity, and Earthquake Hazard

Determining the ages of movement of faults in the South Platte Canyon is quite difficult since no rocks younger than Precambrian (600,000,000 years) are present. Precambrian faults were present and many were reactivated or mineralized during the Laramide Revolution. New faults were also developed during this period. How much movement has taken place along these faults since the Laramide is not known. In the case of the Kennedy Gulch Fault, however, 300 meters of displacement has occurred since the beginning of Oligocene Time (40 million years ago).

Faulting of the crystalline rocks is evident, and a shear zone underlies and is adjacent to the dam site. Certain engineering techniques will be used to compensate for this problem. Generally, the faults have a northwest trend with an easterly dip. Some faults consist of broad shear or fracture zones. The most notable fault is the Willow Creek, which strikes approximately west-northwest. The course of Willow Creek follows the fault very closely. Bear Gulch, Cottonwood Gulch and an unnamed drainage north of Cottonwood Gulch are all well developed and follow faults parallel to the Willow Creek fault. Several faults which trend (strike) in a northeast direction are considerably less well developed than are the northwest trending faults. The northwest trending fault system predominates in the metamorphics and roughly parallels the foliation (resembling bedding planes in sedimentary rocks) of the rock unit. The northeast-trending system appears to radiate from some point southwest of the town of South Platte.

Although the historical seismicity of Colorado is fairly low (Simon 1969), the record is too short to provide an accurate assessment of the earthquake hazard of the State. Several lines of geologic evidence suggest that the seismicity of several parts of Colorado may be considerably higher than indicated by the scanty historical record (Scott 1970; Mathews 1973; Kirkham 1977; Colorado Geological Survey 1974).

Quaternary fault displacements indicate the occurrence of large earthquakes in Quaternary time and would be valuable in appraising the likelihood of future earthquakes in the area. Quaternary time is an occurrence within the last 3,000,000 years. The existence of Quaternary ruptures shows that Colorado has had earthquakes in Quaternary time. These earthquakes were large because a magnitude of about 6.5 (Richter scale) is generally considered necessary to cause surface rupturing of rocks (Scott 1970). However, with one possible exception in 1882, no earthquakes of this magnitude have occurred in Colorado in 100 years of recorded history. The Golden Fault, whose expression can be traced south to 12 miles north of the treatment plant, is the fault nearest the area showing Quaternary displacement. The Golden Fault has a long history of movement, probably beginning during the Laramide revolution and producing at least 18 feet of movement during Quaternary time. Resulting earthquakes were probably at least Intensity VII on the Modified Mercalli Scale. With Intensity VII, damage to buildings varies depending upon quality of construction, and the tremor is felt by motorists. Generally speaking, at this level of intensity, people run out of doors.

The dam has been designed for an earthquake of 6.0 at 15 miles. However, the results of the subsequent investigation show that the dam is able to withstand a maximum credible earthquake of 7.4 at 5 miles without collapse.

According to the DWB Foothills Predesign Study, two sets of regional joints or fractures exist near the dam site. One set trends in a general north-south direction and has steep dips (inclination of the plane of the joint) ranging from 70 degrees west through vertical to 70 degrees east. The second set strikes west-northwest, approximately parallel to the foliation, but exhibits southward dips opposed to those of the foliation and ranges mostly from 40 to 65 degrees. The north-south joint set appears more prominently in surface outcrops.

Shearing is evident both in surface outcrops and in cores recovered from boreholes. Shearing is defined as joints exhibiting some small amount of varying movement of the rock masses parallel to the plane of the joint (usually several parallel joints are involved). However, the sheared zones (several parallel shears) are only a few feet wide and each appears to be of limited extent.

Slides and Rock Falls

The foliation of the metamorphic rocks of the Platte Canyon strikes roughly northwest. The foliation is distinguished by bands of light- and dark-colored minerals, often no more than a quarter inch thick. The foliation planes are considered planes of weakness along which an unsupported rock mass can fail or slide (Board of Water Commissioners, Vol. II, 1973). In the canyon the weathered material (rock debris and soil) forms a thin cover over solid unfractured rock. There is little probability of devastating landslides even though the canyon walls are quite steep; however, because the overlying weathered rock is highly fractured, there is an ever-present possibility of falling rocks. Smaller rock falls are probably more common than larger rock falls.

Some of the sedimentary beds east of the Dakota hogback contain a considerable amount of clay and when saturated could become fluid enough to move downslope. Natural slopes in that area are probably in relative equilibrium and should not slide if the vegetative cover and natural slopes are not disturbed. However, in sediments on the flanks of the pediments, landslides can be observed on 25-degree slopes at several places in the Pierre Shale (USGS 1963b).

SOILS

The soils or combination of soils shown on Maps 2-2, 2-3, and 2-4 (located at the end of this chapter) occur within the area of proposed action. These maps show the geographical location of these soils as it relates to the proposal. These soils data are from the Soil Survey of Castle Rock Area, Colorado (Soil Conservation Service (SCS) 1974), and the Soil Survey of Arapahoe County, Colorado (SCS 1971), and the Soil Survey of the Golden Area (SCS 1977).

Soil Descriptions and Interpretations

Soil descriptions and interpretations are illustrated by soil units and associations from referenced soil surveys and are available from SCS, Colorado State Office, Denver, Colorado.

From observing the work which was done by the city of Aurora when installing water facilities in the Foothills Project area, natural productivity of the soil did not affect the reestablishment of vegetation in areas that were disturbed. Natural productivity means that natural elements in the soil were adequate to establish vegetative cover without having to add commercial fertilizers. No fertilizer or additional water was needed to establish a ground cover. The precipitation was sufficient for plant establishment. Table 2-24 contains estimates of soil properties that are of special concern as they are related to this proposal.

Sediment Yields

Sediment yield is defined as the average amount of sediment from a square mile transported by water from its source area into local water courses. This represents a long time average over as much as 25 years or more. A great deal of the quantitative data used to determine these yields were from dry reservoirs and as a result reflect the average weight of volume of sediment deposited in these reservoirs.

The sediment yields for this area were derived from the 1974 Colorado sediment yield map (Colorado Land Use Commission and the Soil Conservation Service 1974) and are in the low yield category, ranging from 0.1 to 0.2 acre-feet per 640 acres per year (Table 2-24). This would amount to approximately 1/2 ton per acre per year using the midpoint of the indicated yield. It is estimated that sediment yield from disturbed soils increases to a point where it falls within the upper parameter of the high yield category shown by Table 2-24. At a rate of 1 acre-foot per 640 acres per year, this is equivalent to a yield of approximately 3 tons of sediment per acre per year.

TABLE 2-24

ESTIMATED SOIL PROPERTIES

Soil	Soil Reation	Salinity (millimhos/cm)	Shrink Swell Potential	Corrosivity		Depth From Surface in Inches	Classification		Hydrologic Soil Group
				Steel	Concrete		Unified	ASSHTO	
Blakeland	6.1-7.8	Slight (0-2)	Low	Low	Low	0-60	SMar SP-SM	A-3	A
Bresser	6.7-7.8	None to slight	Low to moderate	Low	Low	0-5 5-30 30-60	SM SC or CL SM	A-2 A-4 or A-6 A-2	B
Buick	6.8-8.0	None	Moderate to high	High	Low	0-22 22-56	CL CL	A-6 or A-7 A-1	C
Colby	7.5-9.0	Slight to moderate	Low	Low	Low	0-60	CL-ML, or CL or ML	A-4 or A-6	B
Denver	6.1-9.0	Slight (2-4)	High	High	Low	0-55	CH or CL	A-7	C
Englewood	6.6-9.0	Moderate	High	--	--	0-60	CH or CL	A-6 or A-7	C
Fondis	6.4-7.15	Slight to moderate	Moderate	--	--	0-24 24-60	CH SC	A-7 A-7	C
Kutch	6.1-8.4	Moderate	Moderate to high	High	Moderate	0-32	CL or CH	A-6 or A-7	D
Litle	7.5-8.5	Slight	High	High	Low to moderate	0-39	CH	A-7	D
Louviers	6.1-7.8	Slight (0-2)	High	Low	Low	0-12	CL or CH	A-6 or A-7	D
Newlin	6.1-7.8	Slight (0-2)	Low	Moderate	Low	0-22	SM or GM	A-1 or A-2	B
Razor	7.3-9.0	Moderate (4-8)	High	High	Low	0-34	CH	A-7	D
Renohill	5.6-7.3	Slight (0-2)	Moderate	High	Moderate	0-24	CL or CH	A-6 or A-7	C
Satanta	5.6-8.4	Slight (0-4)	Low	Low	Low	0-30 30-60	CL ML	A-6 A-4	C
Thedalund	7.5-8.5	Slight	Low	High	Low	0-30	CL	A-7	C
Truckton	6.1-7.5	Slight (0-2)	Low	Low	Low	0-60	SM	A-2 or A-4	B
Loamy alluvial lands	6.1-8.4	Slight (0-4)	Low to moderate	--	--				
Sandy wet alluvium	6.1-8.4	Slight to moderate	Low	--	--				
Terrace escarpment	----------------------NO Data--								

Source: SCS and Colorado Land Use Commission

To convert <u>acre-feet per square mile per year</u> to <u>tons per acre per year</u> in sediment yield calculations, the following procedure was utilized. The midpoint of the low yield class from the Colorado Land Use Commission and SCS sediment yield map (0.15 acre-feet per square mile per year) was estimated to be representative of the area of this proposal. The 0.15 acre-feet per square mile per year was converted to cubic feet per square mile per year by multiplying 43,560 cubic feet (number of cubic feet in one acre-foot) by 0.15, which is equal to 6,534 cubic feet per square mile per year of sediment yielded. The 6,534 cubic feet per square mile was converted to cubic yards per square mile per year by dividing this number by 27 cubic feet (27 cubic feet = 1 cubic yard), resulting in a sediment yield of 242 cubic yards per square mile per year. In order to reduce this to cubic yards per acre per year, the 242 cubic yards was divided by 640 acres (number of acres within a square mile). This is equivalent to 0.38 cubic yards per acre per year. In order to obtain tons per acre per year, the 0.38 cubic yards was multiplied by 1.2 tons (the estimated weight of a cubic yard of sediment that would be yielded from the area), resulting in an estimated sediment yield of 0.456 tons per acre per year, which was rounded off to 0.5, or 1/2 ton per acre per year.

The same procedure was used in converting the 0.1 foot per square mile per year, which was estimated to be the yield after disturbance under this proposal.

Vegetation

The proposed Foothills Project involves three broad vegetative zones. The location of the proposed treatment plant and conduits is a short grass grassland within the Northern Temperate Grassland of North America (Shelford 1963). Waterton and the surrounding area is classified as lower montane (Marr 1967) of the Boreal Montane Coniferous Forest in North America (Shelford 1963). The North Fork above Bailey is classified as upper montane. These three broad vegetative zones are transected by a riparian subtype, creating four basic plant communities (see Map 2-5 located at the end of this chapter). Detailed species lists and information on the occurrence of species in the project area are available from BLM, Denver, Colorado. Environmental Assessment, Foothills Project, Denver Water Board, by Ecological Analysts Incorporated, supplies species lists and maps for specific ecology in the Foothills area.

The native grasslands zone that occurs on the rolling plains east of the foothills is characterized by mixed stands of buffalo grass, blue gramagrass, western wheatgrass, green needlegrass, sedges, Kentucky bluegrass, fringed sage, prickly pear cactus, and yucca; however, the species composition is dominated by blue grama and buffalo grass. Although annual forbs are common during early spring, they comprise only a small portion of the vegetation. The native plant composition has been greatly modified in many areas of the grassland by heavy livestock grazing, cultivation, and introduction of weedy species such as cheatgrass Data are not available to quantify forage production in the grassland area; however, the area probably produces 800 pounds of dry forage per acre in average years. About 2.2 acres of this forage could support one cow for one month.

Trees and shrubs are not common in the local grassland zone except along stream courses where cottonwoods and willows occur in narrow bands. Tracts of land that have been plowed and farmed are included in the grassland area; small grains and permanent pasture are common domestic crops.

The montane zone is characterized by mixed stands of Gambel's oak, mountain mahogany, snowberry, mountain maple, ponderosa pine, mountain juniper and Douglas-fir. The understory vegetation and grassy areas consist of mountain muhly, Parry oatgrass, bluejoint, bluegrass, Scribner's needlegrass and various forbs.

Gambel's oak and mountain mahogany occur throughout the foothills area; however, these shrubs dominate the aspect of south-facing slopes and the lower portion of Waterton Canyon. The shrub-covered hillsides support a sparse stand of mountain juniper and ponderosa pine trees.

Douglas-fir, occurring in scattered, isolated stands in the lower reaches of the canyon, forms a dominant part of the vegetative aspect of the upper canyon (see Map 2-6 located at the end of this chapter). Dense stands of Douglas-fir usually occur in pockets on the north- and northwest-facing slopes, although scattered trees exist throughout the steep-walled Waterton Canyon. Small clearings or openings in the brush and timber support a variety of grasses and forbs.

To estimate relative amounts of timber, brush, riparian, and grassland vegetation in the Waterton Canyon, acreages of each vegetative type were estimated using aerial photos and USGS topographic maps for an area lying 1/2 mile on each side of the river along the 8 miles between South Platte and the mouth of the canyon (Table 2-25). In the area proposed for the Strontia Springs Reservoir, coniferous timber, primarily Douglas-fir, occupies roughly 35 acres.

Riparian vegetation in the Foothills Project area exists in a narrow strip along each bank of the South Platte River and along Willow Creek, Bear Creek, Stevens Gulch, Mill Gulch, Bear Gulch, and Cottonwood Gulch.

The riparian zone includes various willows, river birch, narrow leaf cottonwood, white fir, Douglas-fir, field horsetail, sweet clover, blue bells, brome and bluegrass. It varies in width but probably averages about 50 feet along each side of the river and about 25 feet in the bottom of the smaller drainages. In Waterton Canyon, riparian vegetation occupies roughly 120 acres or about 2 percent of the area (Table 2-25).

Riparian vegetation occurs to a very minor extent in the grassland area along Willow Creek and Plum Creek. In these areas cottonwood trees and willows are the conspicuous species.

TABLE 2-25

RELATIVE PROPORTION OF VEGETATIVE TYPES IN THE WATERTON CANYON

Vegetative Type	Acres 1/	Potential or Actual Vegetation Production 2/ (Pounds per Acre per Year)	Percentage of Sample Area Occupies
Timber	1,600	1,000	31
Brush	3,350	800	66
Riparian	120	1,500	2
Grass (clearings)	50	800	1
Total area	5,120	4,100	100

1/ Calculated from aerial photographs and USGS topographic maps.

2/ Estimated from field reconnaissance.

Wildlife

The following summary of vegetation and wildlife in Waterton Canyon (South Platte Canyon) is taken from data supplied by Ecological Analysts, Incorporated, at the University of Colorado in Boulder in 1973 (DWB 1974).

> The South Platte Canyon displays rich and varied flora. Based on the current count of over 250 species, it is estimated that the total is close to 270. Vegetation found in the canyon between Stevens Gulch and South Platte represents approximately 1/10 of the species to be found in the entire state of Colorado 9Weber, 1972; Smith, 1966: Daubenmire, 1969; Oosting, 1956).
>
> The shrubs and vines along the river comprise several species that are unique to this sort of habitat (e.g., water birch, Jamesia, which is an orctotertiary relic, wild hops, chokecherry, mountain mahogany, Gambel oak). The plant species found in the dam-reservoir area are, for the most part, not rare. However, it is unusual to see these species so abundant. Gambel oak is near its northern limit of distribution in eastern Colorado (Weber, 1972; Harrisongton, 1964), but is abundant in the canyon. The plants are robust and reproducing well.
>
> Soil condition is important for vegetation growth and ultimately the existence of higher forms of wildlife. The soil and its inhabiting species are interdependent. Animal interactions affect soil formation with droppings, decaying organisms, and plant litter in conjunction with decomposers or decomposer organisms (Taylor, 1935).
>
> Acarina (mites) constitute the major group of organisms found in the soil and are important for their activities, which include digging, channeling, and eating out dead roots (Jacot, 1940). Collembola (springtails) make up another common group in the soil (Ford, 1937). Other animals found in the soil include formicidae (ants), lumbricus (earthworms) and nematodes. These animals, although widespread, appear in less quantity per square meter than do acarina or collembola. Presence of these animal populations indicate productive soils.
>
> A high variance in biomass (total biological material) was found between the different plots of soils that were tested. With the exception of a few plots, soil studies represent "healthy" coniferous biotopes. In a terrestrial environment, the high soil phosphorus content that was found in 12 out of 20 plots tested may be advantageous for the promotion of vegetation growth.

Fifteen species of small mammals were obtained by live trapping in the canyon. This represents a high diversity of small mammals for a xeric (dry) area like the canyon. Two species can be considered rare for the area; the yellow-bellied marmot, which is at the easternmost limit of its distribution, and the prairie vole, which is usually found in wetter habitats than those in the canyon.

Preliminary observations of mammalian faunal distribution and abundance in the Platte River Canyon area, augmented by such historical records as Cary (1911), Warren (1942), and more recently, Lechleitner (1969) and Armstrong (1972), indicate that this ecosystem is one of the richest, in terms of species diversity, in the state of Colorado.

The canyon also contains numerous species of birds. Many breed in the canyon; an additionally large number feed in the area during spring and fall migrations. The diversity of habitats permits a wide range in types of birds, from the stream-feeding dipper to larger raptorial birds.

Willow Creek, Bear Creek and Strontia Springs are some of the more diverse and productive habitats because of the good cover and plentiful food. Warbling vireos, Virginia's warblers, MacGillivray's warblers, western wood peewees, and canyon wrens breed here; bluejays, Townsend's solitaires, solitary vireos, Townsend's warblers, hermit thrushes, and other migrate through the gulch.

The oak thickets are used by the summer resident green-tailed towhees, rufous-sided towhees, Virginia's warblers, yellow warblers, and chipping sparrows. Fall migrants include Wilson's warblers, Townsend's solitaires, and black-headed grosbeaks. The stretch of river to be flooded is used by dippers for feeding and contains several well-protected spots that the dippers have used in the past for nesting. Kingfishers also hunt along this strip of water. Four amphibian ponds exist along the South Platte. One is within the high water line of the proposed reservoir.

The conifer hillsides support birds year-round but especially during the spring and fall migrations. Pygmy nuthatches, mountain chickadees, band-tailed pigeons, and western tanagers are common.

Three species of snakes (prairie rattlesnake, eastern yellow bellied racer, and wandering garter snake) and two species of lizards (red-lipped fence lizard and six-lined racerunner) have been seen in the area proposed for the dam and reservoir.

Two amphibians were seen elsewhere in the canyon. This represents over a third of the herpetofaunal species reported from Jefferson and Douglas Counties.

Detailed species lists and available information on species occurrence in the Waterton Canyon are available on request from the BLM, Denver, Colorado.

Characteristic flood plain birds are the dipper, broad-tailed hummingbird, western flycatcher, warbling vireo, mallard and blue-winged teal. Dippers are year-round residents of rocky stream bottoms. They utilize rocky areas beside the streams for nesting and feed in the water, often by walking on the bottom.

Map 2-7 (at the end of this chapter) depicts the ranges of major species.

Bighorn Sheep

The bighorn is an important game species inhabiting the project area and has been studied in some detail. A study by Jones and Jones is reproduced in Appendix 1. According to this 1973 report, there were approximately 35 sheep which were yearlong residents of the canyon. The herd once numbered about 50 head, but was reduced to 18 during the construction of existing water-system structures. One cause of decimation was thought to be illegal killing by the construction workers, but death from lungworm-induced pneumonia probably occurred also.

The lungworm is transmitted transplacentally and also through the sheep feces via various stages and through tiny land snails which act as an intermediate host. Any factors which would tend to concentrate the sheep would increase the possibility of lungworm infection (Hibler 1972; Parks et al. 1973).

According to the latest information available from members of the Colorado Division of Wildlife (personal communication, Mel dePra, Wildlife Conservation Officer, 1977 and Richard Denney, Big Game Supervisor, 1977), there was a confirmed count of 40 sheep in early March 1977. It is reasonable to estimate the herd at 60 to 65 (personal communication, Foothills ES Fish and Wildlife Subwork Group, 1977).

Bighorns generally remain on the north side of the river but occasionally venture to the south side. They mostly frequent the area of the proposed Strontia Springs Dam and access road. Map 2-7 (located at the end of this chapter) displays the summer and winter range and the lambing grounds for this herd.

Although the sheep are yearlong residents of the South Platte Canyon, during the winter they concentrate in the Waterton Canyon, especially on the south faces between Cottonwood and Bear Gulches. Breeding usually takes place during November and December in these winter concentration areas and lambing occurs in May and June. Water is available most of the year in Willow Creek, Bear Creek, Cottonwood Creek, and at other sites, in addition to the South Platte.

Some of the sheep are accustomed to the presence of humans and are not outwardly frightened by the presence of fishermen and hikers on the road.

In the past four years, the Colorado Division of Wildlife has issued fifteen archery permits to harvest the excess rams from the herd. Of that number, three archers have been successful; two of these three rams were harvested in 1976.

The Colorado Division of Wildlife plans to treat the herd with a drug to reduce lungworm. This stock may then be used as a base herd for transplanting to other areas of the State.

Endangered Species

The peregrine falcon and the Southern bald eagle are the only species classed as endangered by the federal government that are known to inhabit the project area. However, the northern race of the bald eagle which also inhabit this area has been proposed for inclusion in the federal endangered list. There is a remote possibility that black-footed ferrets inhabit the area since there are many colonies of the black-tailed prairie dog in the plains grasslands area. There are two prairie dog colonies along the proposed route of Conduit No. 27 and the second parallel conduit and one colony east of the proposed treatment plant site. However, no documented ferret sightings have been reported in the project area in recent years.

The latest Federal Register's (June 16, 1977) list of plant species proposed for protection by the Endangered Species Act of 1973 was reviewed. No known threatened plant species occur in the area.

The peregrine, which is on both the Colorado and national endangered species list, occurs in the proposed project area although there are no known nesting eyries in the South Platte Canyon; however, an active eyrie does exist in the vicinity of the North Fork. In 1972, it was the only successful eyrie of eleven occupied sites in Colorado.

The feeding areas for these birds consist of the riparian areas along the streams and the grasslands along the foothills. These areas provide a food supply consisting of small birds, waterfowl, and shorebirds for the peregrine. The Rocky Mountain-Southwestern Peregrine Falcon Recovery Team has recommended to the U.S. Fish and Wildlife Service (USFWS) a portion of the North Fork as critical habitat for this eyrie.

Protected and Game Species

Golden eagles are common, yearlong residents in the area. In addition to the nesting pairs, other wintering eagles frequent the grasslands and riparian zones. Nesting usually occurs in the rocky crags in the canyons, but the birds must have a large feeding radius, which usually encompasses the open plains area to the east. A nesting density of one pair of golden eagles per 36 square miles was reported for similar habitat near Fort Collins (USFWS 1964).

Three golden eagle nesting sites have been reported within the project area (Henry 1975). Two of the three known eagle eyries are probably alternate nests of one nesting pair, since they are close together and only one pair of adults has been seen near the sites. Nesting generally occurs during March and April, and one to two young are usually reared per nesting pair. Nesting eagles are intolerant of human harassment during the early stages of nesting; they will usually abandon the eyrie if repeatedly disturbed (Murphy 1973; Boeker and Ray 1971).

The USFWS and Colorado Division of Wildlife are conducting studies to locate and monitor eagle nesting success. They have documented that the nesting population has declined during the last two years. There are apparently surplus nesting sites in the project area for the present nesting population (Craig 1975). The population decline is likely due to low prey populations, especially rabbits.

There is a small herd of about 40 resident mule deer in the canyon. In addition, the area attracts 30 to 40 head of wintering deer. These deer, especially in the winter, use many of the same areas and consume many of the same plants as the bighorn sheep, but at present population levels, no direct competition for space or forage is apparent. Deer use less rocky areas, such as Stevens Gulch, much more than do the bighorns. Pellet group counts in Stevens Gulch indicate an average of three to five deer days of use per acre per year.

The canyon supports a few mountain lions and black bears on a yearlong basis. Occasionally a few elk, generally 15 to 20 head, winter along the high open ridges at the upper end of the canyon. Wild turkeys are generally restricted to the higher ponderosa pine and oakbrush slopes and are seldom seen in the canyon.

A small herd of approximately 60 antelope inhabit the area of the proposed Conduit No. 27 and the second parallel conduit. These animals spend a substantial part of their time on the larger ranches where they are not seriously restricted by fences, roads, and untenable human harassment.

The grasslands area supports scattered colonies of black-tailed prairie dogs, which are a major prey species of the endangered black-footed ferret. Two large colonies of several hundred prairie dogs would be bisected by Conduit No. 27, the second parallel conduit, and the access road. These colonies were previously disturbed by the Aurora pipeline, but burrow density is greater now in the soft soil along the line than on surrounding undisturbed land. No evidence of prairie dogs was located on the site of the proposed treatment plant; however, a large prairie dog town was observed to the east of the site. No sign or sighting of black-footed ferrets has been reported in the area.

Fire

There is no history of large forest fires within the canyon over the past 50 years. The U.S. Forest Service has extinguished, on an average, 1.2 lightning fires per year since 1960 in the Waterton Canyon area. One man-caused fire occurred during this period in the Waterton Canyon area.

CLIMATE AND AIR QUALITY

The climatologic and meteorologic environment of the Foothills area is comprised of the Continental Divide on the northwest, the South Platte drainage basin on the south, and West Plum Creek on the east. Five major climatic components are used to describe the baseline conditions for this area: temperature, precipitation, ambient moisture and evaporation, winds, and air pollution. These elements and their interrelationships are briefly described in the following paragraphs; they represent climatologic data collected from fourteen weather stations in the Foothills area (U.S. Department of Commerce 1970a and 1970b).

Temperature

Average temperature at these locations can be correlated with altitude to a large extent; as altitude increases, the average annual temperature decreases. In general, annual average temperatures range from about 45°to 50°F, with extremes of -35°F to -40°F during the winter and close to 100°F during the summer. Extremes of temperature are usually short duration with fluctuations occurring in any season. At higher altitudes, annual averages are in the mid-30s; at lower altitudes they are in the mid-50s.

Precipitation

Precipitation is heaviest during the spring and summer, with May the month of highest average precipitation (2.75 inches). The average yearly precipitation for the project area is about 16 inches. Thunderstorms are prevalent over the plains of eastern Colorado and along the east slopes of the mountains during the spring and summer. On almost 39 days annually, daily precipitation amounts exceed 0.1 inch in the project area; on about 11 days, 0.5 inch is exceeded.

Ambient Moisture and Evaporation

The ambient moisture levels in Colorado are generally low, favoring rapid evaporation and a relatively comfortable feeling even on hot days. The pan evaporation value for the Foothills area is approximately 55 inches per year. New reservoir evaporation for the Foothills area averages about 24 inches per year.

Winds

None of the weather stations in the Foothills area have records of wind data. However, wind speeds and their directions recorded at Stapleton International Airport in Denver indicate the prevailing wind direction is south every month of the year, and the average speed is 9.3 miles per hour. The highest wind speeds occur in March and April and average 10 to 10.5 miles per hour. Winds with the lowest speeds occur in late summer and early fall, with the lowest average monthly wind speed of 8.3 miles per hour recorded for October.

In the rugged mountainous area of much of the Foothills location, local drainage winds can be the predominant feature. Direct measurements have not been made in the South Platte River Basin to document the occurrence of such winds. However, on the basis of measurements made in other areas of the state with similar conditions, it is assumed they do exist. The same types of mountain-valley wind systems can be expected to occur in almost every canyon. Where canyon walls are very steep, relatively little wind is generated. However, where canyon walls are narrow and have gently sloping terrain up canyon, strong flows can occur as air masses move down the valley.

Air Pollution

Although no air quality data are available for the project area, personal observations indicate that air quality standards are not violated except for total suspended particulates. The primary annual particulate standard for Colorado is 75 micrograms per cubic meter, with a maximum of 260 micrograms per cubic meter in a 24-hour period.

The nearest state-operated air quality monitoring station to the project area is the Centennial Wells Station near Littleton, Colorado, located about 15 miles away. This is one station within the Denver Air Quality Maintenance Area (AQMA) system. In interpreting the March report, "Analysis of Air Quality in the Denver Air Quality Maintenance Area" (Colorado Air Pollution Control Division 1977), the most typical existing air pollution problem in the metro Denver AQMA is that of particulate matter exceeding the designated area standards. In 1974, the Centennial Wells Station measured an average of six observations per month exceeding the designated area standard for suspended particulate matter.

Presently, only three sources of air pollution exist within the Foothills area: dust from roads, heat from living quarters, and campfire smoke. Dust from dirt roads is the most prevalent source. Cars traveling over dirt roads produce dust that settles slowly and is confined within

the valley for a period of time. Smoke from campfires is generally confined to the valleys. Unlike air over the metropolitan Denver area, which exceeds air quality limitations for carbon monoxide, oxidants, and particulates, air in the project area exceeds only the standard for particulates. This is probably the result of fugitive dust.

NOISE

Because of the remote setting of the study area, its noise levels are now low. Ambient levels recorded from all sources at the treatment plant site and in the foothills away from the river were measured in decibels, adjusted (dBA); they ranged from 32 to 40. River turbulence causes the area's ambient levels to rise to 50 or 60 dBA. The Kassler Treatment Plant and occasional traffic along the access road of the canyon, as well as on arterials leading to the study area, are now the primary sound sources in that area (DWB 1974).

VISUAL RESOURCES

Dillon Reservoir is located in a highly scenic part of the Rocky Mountains in Colorado. The reservoir is a dominant feature within an enclosed landscape (one that does not allow panoramic, long distance views). Because recreation use is a major economic factor in this area, the visual sensitivity is high. This indicates that the area is in a visual management class II situtation, which allows a maximum visual contrast of 10 points (see Appendix 4).

The visual corridor of the project area from the Roberts Tunnel to Kassler forms a narrow valley corridor with varying degrees of spatial enclosure (see Maps 2-8, 2-9, 2-10 and 2-11 located at the end of this chapter). The sense of enclosure is strongest between the Platte Canyon School (1.5 miles east of Shawnee) and Kassler, where lateral viewing distances are often limited to less than 500 feet. The enclosure effect is lessened west of the Platte Canyon School; however, a motorist on U.S. Highway 285 will still find most lateral views limited to one-half mile.

Scenery in this portion of the project area consists of forested and brush-covered foothills with many rock outcrops. Portions of Mount Logan and the Kenosha Mountains (also called the Platte Canyon Mountains) are visible in the middle ground from U.S. Highway 285 between Santa Maria and the Platte Canyon School. In contrast, Waterton Canyon has extremely steep and rocky sides with comparatively few trees (Figure 2-1).

The visual management classes shown on Maps 2-8, 2-9, 2-10, and 2-11 are derived by combining the scenic quality of an area and the area's sensitivity to landscape changes. Visual management classes define limits on acceptable contrast levels for changes in the landscape. (Contrast is a term used to describe the degree of compatibility between a proposal and the existing landscape.) Low contrast values indicate that the visual impacts of a proposal would be relatively low whereas high contrast values indicate that the visual impact would be relatively high (see Appendix 4).

Although scenery involved in the river portion of the project area is better than average, it is not outstanding for the Rocky Mountains of Colorado. The proximity to the Denver metropolitan area increases the importance of the scenery.

The proposed water treatment facility, Conduit No. 27, and the second parallel conduit would be located on both irrigated and non-irrigated crop and pasture lands. The land is in a transition zone between the mountains and the plains (figure 2-2). Although the land is

Figure 2-1. Downstream view of Waterton Canyon below the Keystone Bridge. Note the steep, rocky canyon walls and the strong sense of enclosure found in the bottom of the canyon.

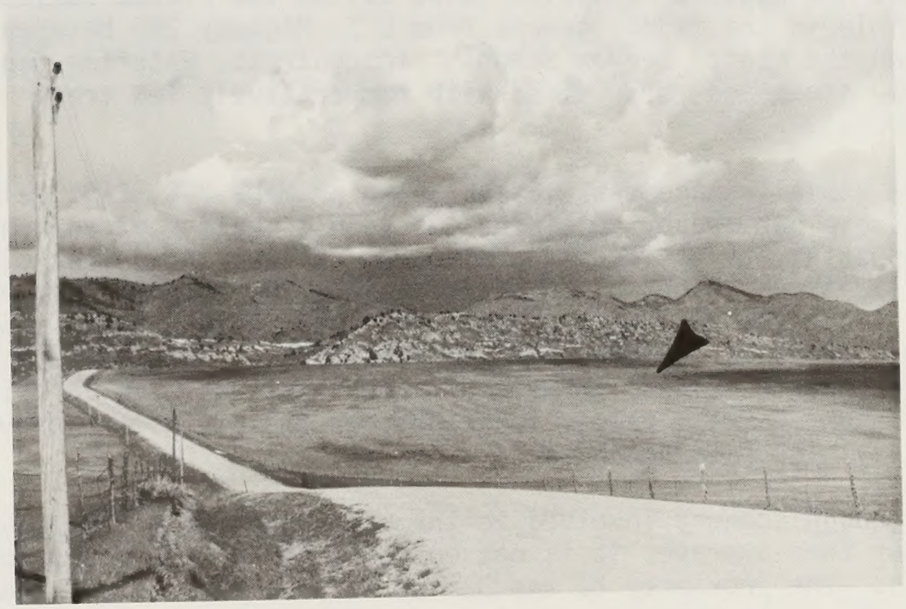


Figure 2-2 View of scenery to the west of the proposed water treatment plant site (foreground). Note the abrupt transition from the plains to the foothills of the Rocky Mountains.

adjacent to the mountains, it strongly displays characteristics of the plains and is generally considered within that physiographic type.

As shown in Figure 2-2, the land involved has flat to gently-rolling topography with grass and some shrubs (e.g., yucca and sage) forming the vegetative cover in non-irrigated situations. The Aurora Rampart Reservoir is the only permanent water body in the immediate vicinity of the proposal; however, it is not visible from the area that the proposed treatment plant and conduit would occupy.

Past and present human use and occupation in this area has also resulted in numerous encroachments on the natural landscape. As shown in Figure 2-2, the immediate site is adjacent to roads, telephone lines, and fences. Denver (with its associated air pollution), power transmission lines and substations, and some industrial development are visible from this site. Due to the extent of the existing human intrusions in this area, it is considered to have a low sensitivity to change.

CULTURAL RESOURCES

Archaeological Resources

The proposed project and areas immediately adjacent to it have yielded data representative of almost every prehistoric period known for this section of the Rocky Mountain Province. These include the epi-Pleistocene Agate Basin, Scottsbluff, and Frederick (ca. 8000-5000 B.C.) (Irwin-Williams and Irwin 1966; Scott and Gillio 1975), Early Archaic (5000-3000 B.C.), Middle Archaic (3000-1000 B.C.), Late Archaic (1000 B.C.-A.D. 400), Woodland (A.D. 400-1000), Upper Republican (A.D. 1000-1300), Dismal River (ca. A.D. 1700), Historic Ute (A.D. 1845-1881) (Windmiller and Eddy 1975), and Cheyenne-Arapahoe (ca. 1720-1860) (Olson et al. n.d.).

A portion of the archaeological resources in the proposed project area were documented by a reconnaissance of the impoundment area, treatment plant, and main canyon access (DWB 1974) and augmented by two brief test excavations in the proposed treatment plant area.

Survey results did not indicate any evidence of archeological remains in the proposed pool area or along the Waterton Canyon access road. Four sites were located at the proposed treatment plant site, and two were subjected to testing. Although both sites exhibited shallow deposition, the "LHS" site produced substantial amounts of cultural debris and a possible hearth.

Survey and excavation conducted further upstream by Dr. Frank Eddy was completed in anticipation of the proposed Two Forks project and, upon review, none of those data would be affected by currently proposed actions.

That portion of the plains to be disturbed by the construction of Conduit No. 27 was surveyed by Dr. Jack Smith of the University of Colorado at Denver on September 3 and 4, 1977. Only one site--a greatly disturbed nondiagnostic lithic reduction station--was discovered throughout the entire route (Smith 1977).

Historical Resources

As early as 1859, miners seeking gold used the canyon from Bailey to Kenosha Pass as a route to the gold fields of South Park. Such towns as Fairplay, Alma, Buckskin Joe, and others were served by this corridor. However, it was not until 1876 that the canyon was modified into its present condition. In that year, the Denver South Park and Pacific Railroad (DSP&P) (Figures 2-3 and 2-4) began construction of a narrow gage line up the canyon and across South Park. This railroad was highly

Figure 2-3. The Denver South Park and Pacific Railroad bed and the Keystone Railroad Bridge, Waterton Canyon.

Figure 2-4. D&RG RR rockwork in the Waterton Canyon.

significant in that it was one of the first mountain rail lines in Colorado, and it was built to serve the timber and mineral bearing region of South Park. Of more importance later on was the fact that it provided rail service to Leadville (via a wagon road over Mosquito and Weston Passes) when the great silver discoveries were made in the upper Arkansas valley.

The DSP&P's key rival was the Denver and Rio Grande Railroad. The Rio Grande, in 1880-1881, attempted to use the South Platte Canyon to build a second line into South Park. However, after construction was begun at South Platte, Colorado, and proceeded downstream, the Rio Grande gave up the project, leaving behind several miles of expensive unfinished roadbed. This left the DSP&P the undisputed ruler of the gateway to South Park. Many of the station sites along the DSP&P's mainline became the towns of today. South Platte was founded in 1877, and places like Buffalo Creek and Pine were founded with the arrival of the railroad in the 1870s. Bailey and Grant were founded prior to the DSP&P's coming.

After many years of marginal freight and passenger operations, the DSP&P line was removed in 1938 and the line was scrapped. The existing roadbed from South Platte, Colorado, to Buffalo Creek, Colorado, was widened and converted into an auto road.

While the DSP&P was in operation, numerous tourists' facilities developed along the right-of-way. In Waterton Canyon, itself, Strontia Springs (Deansbury Station) was developed as a health and tourist spa. Upstream from this spot, little settlements such as Longview, Dome Rock, Foxton, and Buffalo Creek catered to the demands of weekend and summer tourists. As early as 1876, the DSP&P provided transportation into this region, and the area was heavily used by Denverites and out-of-towners to spend many hours enjoying the mountain air and scenery of Colorado.

The existing sites along the river and the railbed rockwork are the physical remnants of the development that took place in the 1870s (Figure 2-4).

Upon consultation with the State Historical Society of Colorado, the State Historic Preservation Officer, and the National Register of Historic Places (1976) it has been determined that one object, the Keystone Bridge (Figure 2-3), had been determined eligible for the National Register (1975). BLM is of the opinion that the D&RG RR rockwork may be determined eligible. A field inventory was conducted in 1974 and 1977 within the canyon, and those sites that would be affected by the proposed action were then evaluated. The following sites are in the Waterton Canyon, or within areas of possible effect (Table 2-26).

TABLE 2-26

HISTORICAL SITES RECORDED IN 1974 AND 1977 IN THE STUDY AREA

Name of Site/Object	Site/Object Number	Principal Site/Object Feature	Integrity and Condition	Historical Significance			Physical Size	Ownership
				National	State	Local		
Deansbury Station	N.A.	Ruins	Poor/Poor			X	5 acres	DWB
Strontia Springs	N.A.	Spring	Fair/Fair			X	1 acre	DWB
Telegraph Poles	N.A.	Telegraph line	Fair/Poor			X	10 mi.	DWB/BLM/USFS
Railway Bridge	N.A.	Bridge	Fair/Fair			X	less than 1 ac	DWB
Keystone Bridge	N.A.	Bridge	Fair/Fair			X	less than 1 ac	USFS
Denver & Rio Grande Railbed and Rockwork	N.A.	Railgrade	Fair/Fair			X	5 mi. x 10 ft.	DWB/USFS/BLM

Paleontological Resources

The occurrence of paleontological resources (fossils) which normally are found in sedimentary rocks or very low grade metamorphic rocks would be limited to that portion of the project area east of the foothills. The sedimentary rocks of the great plains are prominent bearers of common marine invertebrate fossils. Extensive lists of fossil localities in the Kassler Quadrangle are available from USGS professional papers (Scott 1963). East of the foothills, fossils commonly occur. Two fossil localities have been reported near proposed structures: (1) in the Codell sandstone member (SW¼SW¼, Sec. 12, T. 7 S, R. 69 W.) and (2) in the shale above Hygiene sandstone member (NW¼SW¼NW¼, Sec. 7, T. 7 S, R. 68 W.).

On October 5, 1971, during the construction of Chatfield Dam, earthmoving equipment uncovered a mammoth skull some 50 feet below ground estimated to be 120,000 to 200,000 years old. The rocks directly underlying the Chatfield Dam are significantly younger than those underlying the features of the proposed Foothills Project. Those underlying the proposed features are not reported to contain any fossil mammals. The rocks are of marine nearshore origin and contain only common shellfish fossils (USGS 1963a). However, in the immediate vicinity are located Paleocene deposits of vertebrates (mammals) (Middleton and Gooding 1976) reputed to be the third richest of such deposits known to the scientific community (personal communication, Dr. Peter Robinson 1977).

RECREATION RESOURCES

Waterton Canyon

The combination of a rapidly descending, essentially free-flowing river, vegetation of diverse types and patterns, a wide variety of animal life, and varied recreational opportunities makes Waterton Canyon a unique recreation area. In addition, the proximity of this steep-walled narrow canyon to the metropolitan area further enhances its importance as a recreational resource. Although no recreational management plan has been prepared by any agency, the Denver Water Board is currently providing non-motorized access to the canyon, litter control, and restrooms for recreationists.

Numerous recreational opportunities are available in the canyon. Photographers enjoy the varied terrain and abundance of plant and animal life. Particularly attractive is the opportunity to photograph bighorn sheep which inhabit the area. The canyon is also used for white water canoeing and kayaking. Reaches of the canyon were used for olympic trials practice in 1972. The difficulty of the rapids (rated class 4 and class 5), the length of the boating season, the scenery, and the proximity to the metropolitan area make Waterton Canyon a kayak run which is recognized nationally by kayak enthusiasts.

History buffs are attracted by the road grade and bridge remnants of the narrow gage railway that was a popular excursion route around the turn of the century. The old roadbed also provides access for fishermen, hikers, and bicyclists. There are opportunities to study geology, plant life, birds, and wildlife in a setting that rates above average for its visual and aesthetic qualities.

The accessibility to the metropolitan area, the wide level roadbed, and the gentle gradient combine to make the canyon a desirable recreation area for the handicapped. The Colorado Mountain Club sponsors a White Cane hike for the visually handicapped each year.

The exact number of recreationists visiting the canyon each year is unknown. The Bureau of Outdoor Recreation estimates that there were 10,000 users in the canyon in 1976. Others estimate that this figure may be as high as 20,000. Since no counts have been made, it is not possible to make a precise estimate; nor is it possible to break these estimates out as to type of use (hiking, fishing, kayaking, etc.).

Treatment Plant Site

The proposed tunnel from the Strontia Springs Reservoir would pass beneath a combination of national forest and privately owned lands. The most unusual area along this part of the proposed project is the spectacular outcroppings of reddish-brown sandstone conglomerate in Roxborough Park. The tunnel would pass beneath this 3,200-acre land form area just before surfacing at the east portal.

The proposed location for the treatment plant and the conduits, which lies east of the scenic rock formations of Roxborough Park, is characterized by low, rolling, undeveloped grassland. Several roads cross this relatively unbroken landscape, providing opportunities for sightseeing, driving for pleasure, and sighting small mammals and birds. There are no developed recreational facilities nor data available to quantify the degree of recreational use in the area.

Chatfield Reservoir, located downstream from Waterton Canyon on the South Platte, is being developed to accommodate a large amount of recreational use. When fully developed, the 1,300-acre area pool and surrounding area will support an estimated 2 million visitors annually. Current developments include bicycle and horse trails, playground areas, nature study areas, and parking areas. Between July 1976 and July 1977 there were 347,263 visitors to this area. Primary activities included fishing, bicycling, horseback riding, and picnicking. The state has been unable to acquire sufficient water to maintain the 1,300-acre pool and, until they do, water-oriented activities such as boating will not be possible.

The Chatfield-Waterton Canyon-Roxborough area is the location of many non-motorized trails relating directly to the State Trails Program. Chatfield State Recreation Area contains many hiking, horseback, bicycle, and environmental study trails. The Roxborough State Park trails provide for hikers, horseback riders, and handicapped users. The Highline Canal Trail begins at Waterton and extends for 60 miles through metro Denver and Aurora. (One trailhead of the proposed Colorado Trail is likely to originate in the vicinity of Waterton and extend through Waterton Canyon.)

LAND USE

Land ownership patterns in the project area are dominated by publicly owned land west of the foothills and by non-federal lands on the plains east of the foothills (see Maps 1-2, 1-3, and 1-4 at the end of this chapter). In the Waterton Canyon about one-third of the land is owned by the DWB and the remaining two-thirds is public land. Administrative responsibility for managing federal lands in and around Waterton Canyon is shared by the U.S. Forest Service (USFS) and BLM. Although most of the federal land in the area is under USFS administration, roughly half of the federal land in the canyon is managed by BLM.

The proposed Strontia Springs dam site and its immediate construction staging area would be on public lands established by Presidential Proclamation No. 29 of June 23, 1892, in the Pike National Forest. The reservoir area above the dam would be on national forest land, on DWB land, and on public lands administered by BLM. The access road, powerline, and telephone line proposed within Waterton Canyon upstream from the Waterton Canyon Intake Dam would be on both BLM-administered land and national forest land.

The Kassler-Waterton segment of the South Platte River as well as the South Platte-Grant segment of the North Fork has been of interest for water storage or power development for more than 70 years. All of the public lands, both BLM and national forest, affected by the proposed dam and access road and powerline and telephone line have been reserved for power purposes since 1909 by the Federal Energy Regulatory Commission (formerly the Federal Power Commission) or for water storage since 1943 by the Bureau of Reclamation's proposed South Platte Project (see Map 1-2 following Chapter 1).

The rough foothill area lying between the South Platte Canyon and the plains is predominantly national forest land while land east of the foothills is, for the most part, privately owned. Ownerships range from private individuals to corporations and from municipalities to state government.

The public lands are administered for multiple use purposes. Although each tract of federal land is incapable of sustaining all uses, some of the following uses may be supported: recreation, grazing, wildlife habitat, watershed, mineral production, forestry, and specialized uses such as rights-of-way for dams, tunnels, powerlines, and roads. The Forest Supervisor, Pike and San Isabel National Forests, has stated that the proposed project is not inconsistent with the existing multiple use plan for the Forest Service.

The Foothills Project area lies on the southern edge of the expanding Denver metropolitan area. Land uses existing in the project area include urban, light industrial, grazing, farming, woodland, and extensive recreational use. Maps 2-12, 2-13 and 2-14 (located at the end of this chapter) show the general area and extent of existing land uses in the vicinity of the project.

Land uses in Waterton Canyon, limited by the rough rocky terrain, are mostly confined to the narrow canyon bottom. Recreational use and water diversion facilities (dams, conduits, tunnels, roads and powerlines) operated by the DWB and the city of Aurora form the most conspicuous uses of the canyon.

A DWB caretaker's house at the South Platte Intake Dam is the only residence in the canyon. None of the land is used for livestock grazing, and forest or woodland products or mineral materials such as sand and gravel are not being taken from lands in the vicinity.

The topography along the route of the proposed tunnel has precluded conversion of the present woodland or open space to more intensive land uses. The city of Aurora's Rampart Tunnel No. 2 passes under the area. The Public Service Company's (PSC) 230-kilovolt electric transmission line from the Malta substation near Leadville, Colorado, to the PSC Waterton substation crosses northwesterly about midpoint of the proposed tunnel route.

Roxborough Park, under which the eastern one-fourth of the tunnel would pass, is a planned community development of rural residential homesites and condominiums. About 50 individual homes or condominiums have been started; however, most have not been finished because of bankruptcy proceedings involving the entire acreage. Presently, there are 8 families residing in the development, although it is designed for about 20,000 residents.

The high plains in the vicinity of the east portal of the proposed tunnel, Conduit No. 26, the water treatment plant, Conduit No. 27, and the second parallel conduit have been in non-federal ownership for 75 to 100 years. The lands in this area are in single (presently agricultural) ownership that range in size from 80 to 1,000 acres. Many of them in the vicinity of the treatment plant site are in a speculative transition to rural subdivisions. The Highlands Ranch, lying along the route of the proposed Conduit No. 27 and the second parallel conduit, is a large, single-ownership grazing area of more than 20,000 acres.

These lands have retained their rural pastoral character and are used principally for livestock grazing. There are occasional small patches of subirrigated meadowland or fields that are dry-farmed for small grains. Light industrial and commercial developments occur at the intersection of U.S. Highway 85 and Titan Road and nearby at Louviers. Such land uses are not common in the area.

Between Highlands and Hillcrest Reservoirs, the land use pattern changes from open-space grazing to urban developments. The urban areas along the southern edge of the metropolitan area are relatively new and are separated by considerable undeveloped acreages. Within 1 mile of the proposed conduit in this area there are approximately 5,880 developable acres, of which 2,970 are presently developed. The urban development presently extends to about 1 mile north of County Line Road between Arapahoe and Douglas Counties. A variety of land uses occur in this area, including grazing, farming, developed residential neighborhoods, streets, and developing subdivisions. Along the conduit most of the farming is for wheat or other small grains.

BLM approved a right-of-way in 1966 for the city of Aurora to construct a diversion dam and reservoir of about 0.8 acres on the South Platte River about 1-1/2 miles upstream from the proposed Strontia Springs Dam. A USFS special use permit is also involved with the city of Aurora. A 5-foot diversion pipeline buried in the roadbed extends east along the river to the Strontia Springs dam site where it feeds into Rampart Tunnel No. 1. An underground conduit in Stevens Gulch connects Tunnel No. 1 with Rampart Tunnel No. 2, which brings water to Aurora's Rampart Reservoir near the DWB's proposed treatment plant.

The city of Aurora's large diameter aqueduct from Aurora-Rampart Reservoir to Aurora crosses the high plains area along roughly the same alignment proposed for Conduit No. 27, past Highlands Reservoir to East Dry Creek Road and South Colorado Boulevard, where the two routes would separate.

Seven miles north of the site of the proposed treatment plant, the Corps of Engineers' Chatfield Dam was completed in 1975. It is a flood control dam on the South Platte River and Plum Creek, which will be maintained as a core for a public recreational area now being developed under the administration of the Colorado Division of Parks and Outdoor Recreation.

The project area is relatively undeveloped. In Douglas County, regulation of land use is controversial. The county's comprehensive plan, adopted January 23, 1974, was declared null and void on February 11, 1975, and the adequacy of the county's regulations relating to new communities is currently being questioned. The county has declined to issue regulations designating new communities and matters of State interest under Colorado Revised Statutes 24-65. The Colorado Land Use Commission now has to decide whether to let the matter pass or whether to enforce state law through court proceedings. Jefferson County has zoning appropriate to the rough foothills area of the canyon, with zoning for intensive urban and suburban uses on the areas east of the foothills. Arapahoe County's suburban character is reflected in more restrictive zoning than Jefferson County's, principally for residential use in the vicinity of Conduit No. 27.

The transportation system shown in Maps 1-2, 1-3, and 1-4 provides relatively easy access to most of the area affected by the project. Access in the South Platte Canyon is limited to the canyon bottom by locked gates. Locked gates on DWB property at Kassler and South Platte limit automobile travel into and through the canyon to DWB employees or contractors, city of Aurora, BLM, USFS, and other federal, state, and local government personnel with responsibilities in the area. The area is open to the general public for non-motorized recreation use. The road in the South Platte River Canyon from Kassler to the South Platte Intake (3 miles) is a two-lane graveled road built on the abandoned narrow gage railroad bed that once occupied the canyon. From the intake dam upstream to South Platte, a distance of 6 miles, there is a single-lane unsurfaced road with infrequent turnouts. An existing single-lane unsurfaced road provides vehicles access from the Kassler-South Platte road through Stevens Gulch for one-half mile to the underground conduit connecting Aurora's Rampart Tunnels No. 1 and 2.

Access to the proposed facilities east of the foothills is provided by Douglas County Road No. 7, which is gravel-surfaced from Colorado State Highways 75 and 470 at Kassler to the Roxborough Park Area. The unsurfaced Roxborough Park road provides public access via Titan Road from U.S. Highway 85 to the site of the proposed treatment plant and east tunnel portal. In the rolling plains between Roxborough Park and the Denver metropolitan area, access is generally limited to existing roads, although the gentle terrain does not preclude cross-country travel.

Although much of the country along the alignment of proposed Conduit No. 27 and the second parallel conduit is undeveloped, the Roxborough Park road, Aurora filtration plant road, Titan Road, U.S. Highway 85, and the Highlands Ranch road provide access to the alignment at roughly 1-1/2 mile intervals between the proposed treatment plant site and Highlands Reservoir. At Highlands Reservoir, paved County Line Road links transportation from U.S. Highway 85 to city streets extending southward from the Denver metropolitan area. These public roads and streets provide access to or along the proposed conduit alignment between Highlands and Hillcrest Reservoirs. The preliminary annual average daily traffic volumes for 1975 are shown in Table 2-27 (Colorado Division of Highways Traffic Investigations Section).

Other transportation modes in the area include two railroads which parallel U.S. Highway 85--the Denver and Rio Grande Western and the Atchison, Topeka and Santa Fe. Both have commercial siding tracks at Louviers.

Stapleton International Airport, 25 miles northeast of the project area, is the nearest large-scale commercial air service. Arapahoe County Airport, 9 miles east of the project area, accommodates local noncommercial service. A short landing strip near Louviers, in Douglas County, handles small, local aircraft use.

TABLE 2-27

ANNUAL AVERAGE DAILY TRAFFIC VOLUME (1975 PRELIMINARY) AT CONDUIT NO. 27 CROSSINGS OF OR WITHIN RIGHT-OF-WAY FOR EXISTING ROADS

Road	Daily Traffic Volume
Titan Road	1,400
U.S. Highway 85	4,800
County Line Road	3,900
South Colorado Blvd. between East Dry Creek Road and Arapahoe Road	6,300
Crossing Arapahoe Road	16,100
South Colorado Blvd. between Arapahoe Road and East Orchard Road	4,100
South Holly Street between East Orchard Road and East Belleview Ave.	4,100
Crossing East Belleview Ave.	10,000
South Holly Street between East Belleview Ave. and East Quincy Ave. No data available for traffic volume on East Quincy Ave.	2,850
Colorado Highway 75 between Wadsworth Blvd. and Platte Canyon Road	7,150
Wadsworth Blvd. just north of Highway 75	4,150
Highway 75 between Wadsworth Blvd. and Kassler	7,900

Source: Colorado Division of Highways, Traffic Investigations Section, unpublished.

FUTURE ENVIRONMENT WITHOUT THE PROPOSED ACTION

INTRODUCTION

The description of the future environment without the proposed Foothills Project is based on several important assumptions derived largely from historical data and trends:

1. The total amount of raw water reliably available to the DWB from its collection, storage, and diversion systems will remain at 312,300 acre-feet annually.

2. Human population in the DWB service area will continue to grow as estimated by the Denver Regional Council of Governments (DRCOG). The advisory group for the Foothills Project for socio-economic discussion including representatives of the Colorado Division of Planning, HUD, EPA, BR, BLM, and DRCOG chose to use population projections of DRCOG (Table 1-4).

3. Current trends in water demand patterns will continue. This will be indicative of commerical, industrial, fire protection, governmental user, and operating losses needs that will accompany the projected growth in population. Such trends will be reflected in both the average per capita per day consumption and in the maximum-day per capita consumption.

4. All discussion in this section will be directed to conditions in the year 2001.

The future environment as described is based upon the conditions that are predicted to occur in the foreseeable future. The predictions in turn are based largely on projected population growth for the DWB service area as shown in Table 1-4.

The DWB's capability to treat raw water would be limited to a rate of 520 mgd. In order to insure that the DWB system treatment and transmission capacity is not overtaxed, water-use restrictions beginning early in spring and continuing through fall would be implemented. These restrictions would become more severe with each succeeding year, as the population continues to increase.

Review of Table 1-4 indicates that DWB's present reliable annual raw water supply (312,300 acre-feet) would become inadequate to meet annual demand between 1985 and 1990. If no additional treatment capacity is developed and water-use restrictions are implemented, the reliable annual raw water supply would be fully utilized in 1990. This is indicated by the data presented in Table 2-28. Before 1990, the DWB's ability to deliver treated water during peak-use periods of the year would be limited by available treatment capacity. Beginning in 1990, the DWB's ability to provide treated water would be limited both by treatment capacity and available raw water.

Since water shortages would be inevitable in view of current levels of use during peak-use periods, the greatest restriction that could be imposed would be to limit per capita use to winter months' rates. At the current average winter-use rate (120 gallons per day per capita), the projected reliable annual water supply available for treated water service in the year 2001 (291,356 acre-feet) would serve a population of about 2,200,000, at 50 percent of capacity. The 120 gallons per day per capita is the December through March average use during the 1964 through 1973 period.

Some of the adjustments that would be made are like those of the summer of 1977 (a drought year). The adjustments are occurring outside-the-residence, principally in horticultural irrigation. If necessary, these adjustments will continue until average per capita consumption historically characteristic of winter months occur throughout the year. It is possible for this to happen with little or no change in within-the-residence or nonresidential consumption rates. As shown in Table 2-3, nearly 40 percent of the residential treated water supply for a family of four in the Denver area is used for horticultural irrigation, which amounts to 19 percent of all water used in the DWB system for all purposes.

In the event that the project is not constructed, the population patterns in the six-county Denver area will not be greatly different from those that would occur if the project was constructed--with two exceptions (Walker 1977). First, there would be a tendancy toward

TABLE 2-28

PROJECTED WATER SHORTAGES WITHOUT THE PROJECT AND WITH A LIMITED WATER SUPPLY

Year	Annual 1/ Treated Water Required (ac-ft) 4/	Raw Water 1/ Diversions To Other Uses (ac-ft) 4/	Total 1/ Annual Raw Water Required (ac-ft) 4/	Treated 2/ Water Used (ac-ft) 4/	Raw 3/ Water Used (ac-ft) 4/	Total Raw Water Used (ac-ft) 4/	Raw and Treated Water Shortage (ac-ft) 4/	Treated Water Annual Per Capita Per Day Use (gdc) 5/
1975				207,982	27,883	235,865		208
1980	242,977	24,922	267,899	242,658	24,922	267,580	319	226
1985	269,710	26,243	295,953	265,001	26,243	291,244	4,709	224
1990	298,331	26,238	324,569	286,669	25,631	312,300	12,269	220
2000	371,509	27,023	398,532	291,124	21,176	312,300	86,232	181
2001	378,530	27,210	405,740	291,356	20,944	312,300	93,440	178
2010	441,719	28,962	470,681	293,084	19,216	312,300	158,381	154

1/ From Table 1-4.
2/ Reflects treated water used after imposing use restrictions during peak-use period of the year.
3/ Additional shortages imposed beginning in 1990 due to inadequate raw water supply.
4/ Acre-feet.
5/ Gallons per day per capita.

greater population density in the city and county of Denver since the basic infrastructure is already in place including the water system. In addition, by law, water taps cannot be restricted within the city/county boundaries. Also, there is one district outside the city/county limits of Denver that has a contract for unlimited taps (Milliken, Trumbly 1977). Second, initially Douglas County will not grow at as great a rate as it would if the project was operational due to the circumstance that plans and placement of infrastructure are not as far advanced there as in the other metropolitan counties in the six-county area. The fact that in the other counties a considerable infrastructure is already in place or planned makes it more facile for developers to proceed with plans to construct housing, commercial, and industrial projects in them. As the limits of population densities in the DWB service area are reached, it is highly probable that development and population density rates in Douglas County will accelerate, especially in view of the fact that some of the aquifers in other counties surrounding Denver are polluted (Walker 1977).

In summary, it can be said that population will become more dense in those areas in which placement and plans for infrastructure are more advanced, with the exception of those that cannot increase their water supplies, either because of limited opportunities to obtain more raw water or because of polluted aquifers.

The future without the project would also move the timetable for the decline in average per capita availability of water in the DWB service area forward, meaning that the approach toward average per capita water use rates more like those typical of winter months would come sooner. A significant trend toward winter use rates would begin sometime between 1990 and 2000 (Table 2-28). The probabilities are high that the major public responses to the reduced availability of water would be rationing and conservation of water (see Chapter 8). In the event that rationing and conservation produce an ambience hostile to the established horticulture, a likely secondary response will be a transition toward arid-area-type horticulture and landscaping.

As Table 8-5 indicates, the population within the DWB service area will increase to 1,162,900 in 1990 and to 1,693,700 by 2010. The treated-water capability would remain at 573 mgd from the time onward. The per-capita, max-day gdc will reach 598 by 1980, drop to 493 by 1990, and then drop to 338 by 2010.

It is highly probable that the decreased availability of water per capita on maximum demand days from 1980 onward will cause changes in lifestyles and patterns of living, particularly those related to horticulture. As in the summer of 1977, a drought year, people who put a high value on their horticultural investment will adjust their life patterns in order that horticulture can be irrigated on scheduled days.

Also as available water approaches average winter per capita rates, there will be a tendency to convert to arid-area-type horticulture or other low-water-use landscaping. The lack of water for horticultural irrigation may also persuade developers to proceed to higher density homebuilding. In addition, under low water availability conditions, privately-owned swimming pools would become increasingly difficult to fill and replenish. The demand for new privately-owned pools would probably decrease, whereas there would be an inverse trend in high per capita use swimming pools such as those municipally owned, those in private clubs, and those in apartment, mobile home, townhouse, and condominium complexes.

WATER RESOURCES

As population grows within the DWB service area, the demand for water will also increase assuming per capita consumptions are consistent with current trends. With population growth, water demand will increase until it equals the reliable available raw water supply, 312,300 acre-feet.

Using the 10-year period 1964-1973 to depict the DWB water supply operation, it was determined that an annual average of 189,600 acre-feet of water was treated or delivered to raw water users after operating losses. Of this amount, 126,900 acre-feet was provided by the South Platte and Roberts Tunnel Systems. According to DWB estimates, reliable supply from the South Platte and Roberts Tunnel Systems after losses is 206,000 acre-feet. Therefore, the unused portion of the South Platte and Roberts Tunnel Systems' reliable raw water supply during the 10-year period after losses averaged 79,100 acre-feet. This water is available from Dillon Reservoir and will be included as part of reliable water supply in discussion.

Diversions from Dillon Reservoir will vary with the availability of water originating in the South Platte River watershed that are divertible by the DWB. When streamflow conditions in the South Platte River are good, the DWB will utilize within its water rights more South Platte River water and reduce its demands on the Roberts Tunnel System. Conversely, when streamflow conditions in the South Platte River are deficient, the DWB will draw more water from the Roberts Tunnel System.

Without the proposed action, the DWB would continue to divert raw water for treatment at the Kassler and Marston plants from the South Platte River at the Platte Canyon Intake Dam and Highline Diversion Dam at rates ranging up to about 400 cfs. Diversions at this rate would normally occur during the peak water-use period of the year, generally July and August. In rare situations, all of the 400 cfs could be released from the Roberts Tunnel; however, this would not occur unless there were a complete lack of South Platte River water available for DWB's direct diversion under its water rights and a concurrent lack of South Platte River storage water (or physical constraints impeding the use of stored water) from South Platte Reservoirs. Average annual flows in the DWB system would continue to increase until about 1990, when the amount of reliable raw water presently available to the system would be fully utilized. Without additional raw water supplies, average annual flows would not increase after 1990. Projected average annual flows at a number of locations in the South Platte River watershed are shown in Table 2-29.

TABLE 2-29

PROJECTED AVERAGE ANNUAL FLOW AT KEY GAGING STATIONS
WITHOUT THE FOOTHILLS PROJECT

Gaging Station	Historical 10-year Average Flow (1964-1973) cfs	ac-ft	Projected Discharge 1990 4/ cfs	ac-ft
South Platte River below Cheesman Dam	177	128,200	177	128,200
North Fork of the South Platte River below Grant 1/	68	49,400	-	-
North Fork of the South Platte River at South Platte 1/	157	113,900	-	-
Roberts Tunnel Imports	41	29,600	156	112,900
North Fork of the South Platte below Grant with Roberts Tunnel	109	79,000	224	162,300
North Fork of the South Platte at South Platte With Roberts Tunnel 2/	198	143,500	307	222,600
South Platte River at South Platte with Roberts Tunnel 2/	412	298,000	521	377,100
South Platte River below Denver 3/4/	649	469,500	711	514,600

1/ Flows of the North Fork of the South Platte River at Grant and at South Platte not including historical Roberts Tunnel diversions.

2/ Flows reflect assessed losses of 5 percent on Roberts Tunnel diversions.

3/ Includes the sum of South Platte River at 19th Street gage plus estimated sewage return (57% of additional Roberts Tunnel import) and recorded discharge of Clear Creek at mouth.

4/ 2001 projected flows would be the same, assuming no raw water increase.

Table 2-30 presents the projected monthly average discharge without the Foothills Project at several locations within the South Platte River watershed including Roberts Tunnel imports. These flows are based on a number of assumptions:

1. Full utilization of the South Platte and Roberts Tunnel Systems' reliable water supply is superimposed upon the average streamflow and diversions as reflected by the 10-year period, 1964-1973.

2. Average monthly streamflow of the South Platte River at Waterton is representative of the flow anticipated after full use of the reliable water supply from the South Platte and Roberts Tunnel Systems in the event of the recurrence of a similar 10-year period.

3. Diversions in the reach of the South Platte River between South Platte and Waterton for purposes other than water treatment would remain the same as the average for 1964-1973.

298,000 acre-feet	- South Platte River at South Platte
-148,400	- South Platte River at Waterton
149,600	
-117,700	- DWB - South Platte River and Roberts Tunnel Water Treated (DWB 1964-1973)
31,900	- Historical Diversion

4. Moffat Treatment Plant would operate for a 6-month period, April through September.

5. These discharge values are not absolute due to vagaries of climatic, hydrologic, and demand conditions from year to year.

Channel stabilization work completed in the upper 12.8-mile reach of the North Fork of the South Platte River can accommodate sustained flows up to 680 cfs. Projected average monthly discharges on the North Fork of the South Platte River at Grant without the proposed action are within that level.

As additional waters are diverted from Dillon Reservoir through the Roberts Tunnel, the annual drawdown of the reservoir will increase until the annual dependable raw water supply is fully utilized.

TABLE 2-30

PROJECTED MONTHLY AVERAGE DISCHARGE OF THE NORTH FORK SOUTH PLATTE RIVER AT GRANT AND SOUTH PLATTE, AND SOUTH PLATTE RIVER AT SOUTH PLATTE WITHOUT THE FOOTHILLS PROJECT (INCLUDING ROBERTS TUNNEL IMPORTS) (in cfs) 4/

Month	Roberts Tunnel Imports		North Fork South Platte River at Grant		North Fork South Platte River at South Platte		South Platte River at South Platte	
	Historic 1/ Discharge	1990 2/ Projected Discharge	Historic 1/ Discharge	1990 Projected Discharge	Historic 1/ Discharge	1990 Projected 3/ Discharge	Historic 1/ Discharge	1990 Projected 3/ Discharge
January	22	152	30	169	67	191	134	158
February	17	148	32	163	58	182	123	247
March	20	145	38	163	69	188	149	268
April	37	189	63	215	127	272	332	477
May	26	179	148	301	375	520	900	1045
June	14	30	255	271	490	505	910	925
July	74	90	230	246	362	377	762	777
August	141	199	226	284	348	403	664	719
September	66	218	113	265	182	326	377	521
October	27	208	65	246	123	295	238	410
November	19	159	48	188	93	226	184	317
December	24	152	46	174	73	195	143	265
Average Annual	41	156	109	224	198	307	412	521
Acre-feet	29,600	112,900	79,000	162,300	143,500	222,600	298,000	377,100

1/ Historic discharges are ten year (10) averages for the period 1964-1973.
2/ Based on population projections and historical use patterns, the 112,900 acre-feet raw water available in Dillon Reservoir would be in use by 1990.
3/ The future imports have been reduced by 5% loss at South Platte stations.
4/ 2001 projected flows would be the same, assuming no water increases.

The resulting 83,300 acre-feet reduction of flow in the Colorado River watershed would remove 11,300 tons of dissolved solids from the basin and increase the salinity concentration of Colorado River Water at Cameo, Colorado, by about 11 mg/l and at Imperial Dam, Arizona, by about 7 mg/l.

It is likely that the DWB service areas may be "bluelined" in the decade between 1980 and 1990 at the point when per capita available water will begin to be reduced (Map 1-5).

There is historical precedence for this from the 1951-57 period when an extended drought and water shortage caused DWB to set a policy of not providing water outside a blue line drawn on a map of the metropolitan area, as discussed in Milliken and Trumbly (July 1977) and Cox (1967).

AQUATIC RESOURCES

The aquatic environment in the South Platte River, in the Waterton Canyon will probably remain stable without the project. There will be increases and decreases in the fish numbers from natural causes, but in the long run numbers will average out to present day levels.

GEOLOGY, MINERALS AND TOPOGRAPHY

The future environment probably would not differ significantly from the present environment. The processes of erosion, weathering, and deposition will continue to make minor modifications of the existing geologic formations and topography; however, in one lifetime most of these modifications would go unnoticed.

It is possible, from existing data, that economic mineral deposits could be found or developed along Waterton Canyon in the future. This conclusion is largely based on a USGS report (1963b) which indicates that metallic and nonmetallic minerals have not been found in minable quantities in Waterton Canyon, but that, based on geologic inference, deposits of uranium or pegmatite minerals may well be present in minable quantities awaiting discovery.

SOILS

Rates of soil development, soil erosion, and soil deposition are expected to continue as they are at present. Much of the natural productive potential of the soils would be lost when urban expansion takes place on much of the flat area. The soils in the canyon and along the riparian zones of the South Platte would be subject to accelerated erosion as a result of increased flows and increased recreation use.

TERRESTRIAL RESOURCES

In the future, the terrestrial ecosystems in Waterton Canyon would be subjected to increasing pressures from recreation visitors. Visitor use and attendant problems are expected to compound, leading to greater harassment of wildlife. The bighorn sheep population in the canyon would probably decrease or move out of these areas. If they remain in the canyon, the herd would probably be managed for 76 head. Other forms of big game would probably decrease in numbers and species diversity. The eagles and the peregrine falcons observed in the area would probably seek a more secluded place to nest.

Continued subdivision, road construction, and water appropriation on surrounding private land is certain. Species such as raptors and big game animals, which are wide-ranging and not able to exist solely in the canyon, would probably continue to decrease in total numbers and species diversity.

The grasslands' ecosystem would probably continue to decline in diversity from excessive livestock grazing, subdividing, road construction, and expanded human encroachment.

The value of the Waterton Canyon as a relatively undisturbed area would increase greatly as habitat conditions decline in the surrounding area due to increased people pressure.

As recreation visits to the canyon increased, risk of man-caused fires would also increase.

CLIMATE AND AIR QUALITY

Although climate is not expected to change, air quality in the project area would probably be reduced as the result of the encroaching urban area. Air pollution would increase as urbanization increased with or adjacent to the project area. No data are available describing precisely how this future urbanization increase would occur. It may be assumed that under a reduced treated-water supply situation, with the attendant loss of horticulture, there would have to occur a corresponding increase in suspended particulate matter.

NOISE

Without the proposed project, the noise levels in the project area could be expected to remain about the same.

VISUAL RESOURCES

Increased recreational use in the canyon along the North Fork and in the area of the proposed treatment plant would gradually reduce the scenic quality and visual integrity of the project area.

CULTURAL RESOURCES

Considering trends in projected population growth and urban expansion, points of cultural value in the project area can be roughly projected as follows.

1. Archaeological resources would experience considerable abuse through uncontrolled surface collecting and digging, activities that are going on in the area at the present time. Urban expansion toward the treatment plant site would probably destroy many archaeological sites.

2. The railroad grades (including associated cuts and rock work) would undergo further alteration and deterioration through use, access road upkeep, and the effects of weather; however, they should not be drastically changed.

3. The Deansbury Station and Strontia Springs sites should remain in about the same condition they are today, unless they are flooded or vandalized.

4. Without the project, paleontological potential would remain the same.

RECREATION RESOURCES

In the future, as the Denver metropolitan area expands toward the south along the Front Range, the resultant population would generate increasing demands for a variety of recreational opportunities. Recreational resources found in the South Platte River system would be subjected to increasing recreational demands.

For example, with continued access the estimated 10,000 to 20,000 annual visits that occurred in the Waterton Canyon in 1976 would increase at least in proportion to population increases and probably at greater rates until restrictions are placed on visitor use.

Under a properly developed and enforced recreation program, the environment of the canyon could likely remain a high-quality resource. The nearly natural qualities and abundant recreational opportunities which are provided by this area would become increasingly unusual and desirable as the metropolitan area grows. The potential would remain for reconstructing the narrow gage railroad for tourism use.

Most of this area is within the South Platte Planning Unit of the Pike and San Isabel National Forests. The Pike Land and Management Plan is currently scheduled for completion in 1983. Prior to completion of the management plan, the Forest Service would provide the facilities necessary for resource protection and management of recreation use.

Between 1980 and 2000, the Forest Service could be expected to expand recreational opportunities to an optimum level which would consider additional development sites as well as providing for dispersed recreation.

Increasing flows in the South Platte River system will continue to limit the associated recreational opportunities Channelization efforts will continue downstream from Bailey to handle increased flows. Large water flow volumes will continue to be hazardous to river users, especially fishermen and boaters.

Utilization of the raw water in the South Platte River system would increase as population in the DWB service area grows.

Roxborough Park, a proposed 756-acre state park now in the acquisition stage, will be established to accommodate recreational needs of the expanding population. This unique area, featuring reddish-brown sandstone conglomerate outcrops and spires, will be primarily for daytime outdoor recreation, i.e., nature study and trails for walking and horseback riding. Other activities will include sightseeing, photography,

and picnicking. The park will also include an interpretative center, picnic sites, and parking lots. The area will handle about 1,000 visitors per day. Trails leading into the national forest to the west from Roxborough Park could provide a non-motorized access route into Waterton Canyon.

Chatfield Dam will retain a permanent recreation pool that covers about 1,300 surface acres. Recreational facilities which are being planned and developed by the Corps of Engineers will be managed by the Colorado Division of Parks and Recreation to provide recreational opportunities that will help meet the needs of the growing metropolitan area. Activities such as boating, fishing, picnicking, overnight camping, and hiking will be accommodated adjacent to an area where considerable growth is anticipated.

LAND USE

The principal source of current (1977) information for forecasting future land use without the project is the staff of the Denver Regional Council of Governments (DRCOG) which includes Adams, Arapahoe, Boulder, Denver, and Jefferson Counties. Douglas County adjoins the region on the south and depends on it for trade, jobs, and social amenities. The projected DWB service area (Map 1-5) includes all of Denver County and parts of all the other counties, including Douglas.

In a large metropolitan region such as Denver, there is an established set of infrastructures that set the direction for land use and development. According to a report by Milliken and Trumbly (1977), the Denver Water Board, for example, cannot refuse to provide water to anyone within the city limits (according to the city charter) and must by contract serve all property within one outside-of-the-city district.

As pointed out earlier in this chapter in the Socio-Economic section, the trend will be toward a higher density of population in the city and county of Denver. The next highest rate of settlement will occur where the DWB service area and other infrastructure is established.

Possible DWB institution of a "blue line" sometime in the 1980-1990 period when per capita available water will begin to be reduced (Map 1-5) may further strengthen trends to these two situations thereby reversing land use/ownership patterns, i.e., acceleration of development of presently underdeveloped areas.

Development or extension of infrastructures into the presently undeveloped areas of the other counties outside the city and county of Denver are expected to proceed more slowly.

Of these latter areas, portions of Douglas County are more likely to be developed first because of favorable aquifer conditions from which new water could be pumped. Approximately six municipalities and 15 smaller water agencies in the Denver region rely solely upon bedrock aquifers for their entire water supply, and 12 other municipalities and water agencies use water from the bedrock aquifers to supplement surface water supplies (DRCOG July 1977). This has resulted in withdrawal of large quanities of water and large declines in the water reserves in the alluvial and bedrock aquifers in the region. Pollution of some of these aquifers has occurred (personal communication, Walker December 1977). In contrast, the aquifers in Douglas County are relatively undeveloped but technically developable and have been estimated to be capable of supporting a population of 250,000 for 100 years within the constraints of Colorado water law (personal communication, Johnson 1977).

To the extent these aquifers outside Douglas County can support additional use or can be reclaimed, some land use changes from additional development could occur.

In the period between 1960 and 1970, land devoted to urban uses in the Denver region increased 12.3 percent; most of it was from the agricultural category. Land in agricultural use declined by 6.8 percent, aggregating about 33,600 acres lost to agricultural use. By the year 2010, about 134,000 acres, or 29 percent of the agricultural land in the region, is expected to be converted to other uses. The amount of urbanized land has increased until about 234,000 acres in the five-county Denver region is urbanized.

"There is enough vacant land zoned for urban uses to provide living space for 6,000,000 people" according to the Environmental Protection Agency.

> The forecasted sharp declines in agricultural land use in the five county area represents only part of the likely future state of agricultural activity in the region. As the agricultural lands on the fringe of the Denver urbanized area are gradually converted to urban use, there will be increased pressure to expand and intensify agricultural activity in areas just beyond the metropolitan region. These pressures would be felt most strongly in eastern Adams and Arapahoe Counties, southern Weld County and northern Douglas County. If supplies of water for agricultural use permitted, increased agricultural production in those areas would take place, with little loss in overall production despite urbanization of some cropland. However, water is a far more important constraint on agricultural activity than is land in this region, and local agricultural experts report that urbanization threatens continued agricultural activity less because it absorbs agricultural land than because of competition with domestic water users in the allocation of water. The condemnation of water rights may make farming economically infeasible long before pressures for conversion of agricultural land are experienced. [EPA 1977]

The foregoing represents an overall view of probable future land uses in areas away from the project features. As to the immediate vicinity of the project features, the following appears to be the most probable future land uses if the project is not constructed. Maps 2-15, 2-16, and 2-17 (at the end of this chapter) portray some of the anticipated future land uses. Presence or absence of the project features does not play a large part in future land ownership. Lands in Waterton Canyon and along the tunnel route would remain publicly owned, except their management would likely be by only one federal agency. It is probable that some of the private lands within the present USFS boundaries would be returned to federal ownership through exchange, purchase or donation.

It is likely that the DWB would retain the land it presently owns at the east portal of the tunnel and at the treatment plant site, the right-of-way for Conduit No. 27, and the second parallel conduit. The city of Aurora would retain its diversion, tunnel, reservoir, and the linear easement for its aqueduct. Private ownership of lands in the vicinity of the treatment plant site and along the route of Conduit No. 27 and the second parallel conduit would continue but would change from the present large acreage single ownerships to many small acreage units and some residential development and a small amount of commercial development.

The rough topography along the tunnel route would preclude conversion of the land to more intensive uses; however, increased recreational use could be expected with development of adjacent Roxborough State Park, Chatfield Lake State Park, and full development of the presently-platted Roxborough Park Planned Development Community. Present zoning and comprehensive land use plans accommodate some commercial and light industrial use in the general area of the treatment plant site; such uses could be expected to develop.

Also in the vicinity of the treatment plant site, small acreage residential units would supplant present rangeland use. Along most of the route of Conduit No. 27 and the second conduit parallel to it in Douglas County through present agricultural, rangeland and open space areas, land use change to light or moderate density could be expected. Interspersed open space would occur where drainages or other land features preclude intensive development. Commercial and light industrial use would also occur on a limited basis.

An additional large diameter water conduit would probably be installed within Aurora's present aqueduct easement from Rampart Reservoir. Figure 2-5 displays an existing and future linear area of non-development similar to what might occur in the future along Aurora's right-of-way. Circumstances are more favorable for moderate density residential development along the route on Conduit No. 27 and the second parallel conduit within Arapahoe County. Most of the present agricultural, pasture, and open areas would be developed for moderate density residential use, with some areas changing to commercial, office, and light industrial use.

Full development of the Roxborough subdivision and Roxborough State Park and changes to agricultural subdivisions would result in improved roads into the area of the treatment plant site. Utilities would be upgraded. Land use changes from rangeland to residential, commercial, and light industrial along the route of Conduit No. 27 and the second parallel conduit would stimulate upgrading of existing roads and utilities and construction of many new ones.

It is probable that urban growth would continue in the future at a rate about equal to that experienced in the past--that is, a real urban

development of 73 acres annually within 1 mile of Conduit No. 27 and the second parallel conduit and a linear growth rate of about 0.1 mile annually from north to south. At this rate it is probable that the southern limit of development in 2001 would be County Line Road. At this point it is probable that linear growth would be slow, but areal growth would continue. Development in Douglas County would probably depend on a large-scale concept with self-contained support features. This may cause a delay in that growth; however, the present rate overall would probably continue south and west. By the year 2001, growth would probably extend along the proposed conduit to Highway 85, and by 2055 (the end of the life of the proposed project) the growth would extend to the Roxborough Park Road at the north edge of the proposed treatment plant complex.

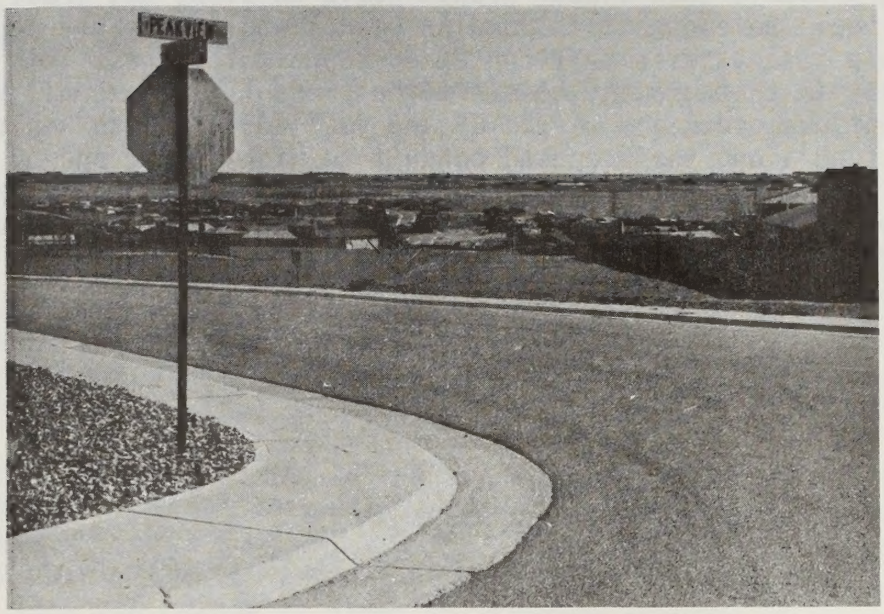


Figure 2-5. The right-of-way for DWB's Conduit No. 85 creates a linear area of non-development where it passes through a developing subdivision.

SUMMARY OF FEATURES OF EXISTING AND FUTURE ENVIRONMENT

Following is Table 2-31, which summarizes the features of the existing and future environment described in Chapter 2.

TABLE 2-31

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (year 1977)	Future Environment (year 2010) Without the Proposed Action
Socio-Economic Conditions	Human Populations:	Human Populations:
	-1,402,500 Regional (1975) (DRCOG).	-2,350,000 Regional (1975) (DRCOG).
	-876,400 DWB service area (1975) (DWB).	-1,693,700 DWB service area (2010) (DRCOG estimate).
	Employment and Manpower: 6.5% unemployment (3/77); 725,600 labor force (3/77).	Industry is #3 on priority list of water after (1) domestic, and (2) agricultural; industries dependent on DWB for daily service would layoff workers in water shortage periods.
	Housing: 563,837 dwelling unit (4/76).	
	Municipal and Industrial Water Systems:	Municipal and Industrial Water Systems: Peak-use period of treated water will need to be constrained beginning at present with further reductions in annual-use necessary at the time (1990). The present raw water supply (312,300 ac-ft) is fully utilized.
	-DWB treated water capacity 520 mgd (1977).	
	-Average Annual use of treated water 181 mgd (215 gdc) (1971-75); average maximum single day use 480 mgd (1971-75).	
	-Treated water storage capacity (DWB system) 287.8 mgd (1975).	-Treated water to DWB's service area would be limited to maximum day rate of 520 mgd; without additional raw water, supply would become inadequate between 1985-1990.
	Consumption rates of treated water (DWB service area) range 117 gdc (January) to 370 gdc (July) (1975); maximum single day is 608 gdc (1973).	-Annual use of treated water 154 gdc.
	-Irrigation uses 40% of residential use.	

TABLE 2-31 (cont.)

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (year 1977)	Future Environment (year 2010) Without the Proposed Action
Socio-Economic Conditions (cont.)	Law Enforcement: 44.6% of 6-county police in city and county of Denver.	
	Fire Protection: -22 fire departments; 1,919 personnel; 209 pieces of equipment in 87 stations.	-Fire protection cannot be maintained at 1977 levels
	-Town Index (Colorado-Wyoming) rating gave Denver a 2 rating (very high); median for counties was 7.	
	Community Attitudes: expression emanates from interested minorities.	Community Attitudes: water rationing would be essential to maintain community services.
	-Growth advocates who see plentiful water necessary.	
	-Restricted growth factions.	
	-Controlled growth groups.	
	-Environmentalists.	
	-Sectional differences between east/west slope.	
	-General public has not participated in bond issues elections; three quarters of registered voters did not participate.	
	-One survey indicates a minority of Denver city-county respondents gave affirmative answers to proposed water treatment projects. A majority in three suburban counties gave affirmative answers.	

TABLE 2-31 (cont.)

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (year 1977)	Future Environment (year 2010) Without the Proposed Action
Socio-Economic Conditions (cont.)	Lifestyles:	Lifestyles:
	-10% of Denver area population below poverty level; average income for family of four is $21,092.	-Reductions to horticulture irrigation.
	-Domestic horticulture extensive.	
Water Resources	Water Rights: Under Colorado law, DWB has right to supply raw water to these treatment plants: Kassler (50 mgd), Marston (260 mgd), Moffat (210 mgd), and raw water users.	Water Rights: the total amount of raw water available to DWB will remain at 312,300 ac-ft annually. Without additional raw water, this supply would become inadequate between 1985-1990
	Flows and Reservoir Levels:	Flows and Reservoir Levels: average annual flows would increase until 1990 when raw water would be fully utilized.
	-1964-1973 raw water, 205,300 ac-ft per year average; treated water, 170,400 ac-ft per year average.	-Raw water, 312,300 ac-ft; treated water, 293,000 ac-ft.
	-Moffat System: Williams Fork River, Fraser River, South Boulder and Ralston Creeks, to Moffat Treatment Plant 52,500 ac-ft (1964-73).	-112,900 ac-ft annual average water release, Roberts Tunnel.
	-Roberts Tunnel System: Dillon Dam and Reservoir (254,036 ac-ft capacity) and Roberts Tunnel (1,000 cfs maximum capacity) (1977); inflow to Dillon average 187,500 ac-ft per year; 29,600 ac-ft average annual release Roberts Tunnel (1964-73).	

TABLE 2-31 (cont.)

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (year 1977)	Future Environment (year 2010) Without the Proposed Action
Water Resources (cont.)	-South Platte System: average annual runoff (1964-73), 298,000 ac-ft; dependent on natural runoff, releases of stored water, and transmountain diversions; lowest average monthly flow in February, highest in June.	Average annual runoff, 377,100 ac-ft
	-North Fork of the South Platte: dependent on natural runoff and Roberts Tunnel diversion from Dillon; channelization between east portal of Roberts Tunnel and Bailey, Colorado, provides for sustaining flows of 680 cfs, and peak discharge of 1,020 cfs.	
	-Miscellaneous Minor Waters:	
	-Willow Creek, Bear Creek, Stevens Gulch: unquantifiable discharges.	
	-Plum Creek: 154,000 cfs maximum instantaneous flow (1965).	
	-Spring Gulch, Marcy Gulch, Dad Clark Gulch, Willow Creek: unquantifiable drainages.	
	Ground Water:	Quantity of ground water would be less
	-Fissures pass water.	
	-Pierre formation is poor aquifer.	
	Water Quality:	Water Quality:
	-Physical, chemical, bacteriological data tabularized. (Tables 2-16 and 2-17)	-Salinity concentrations in the Colorado River would increase by about 11 mg/l at Cameo and 7 mg at Imperial Dam.
		-Water quality would decline.

TABLE 2-31 (cont.)

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (year 1977)	Future Environment (year 2010) Without the Proposed Action
Water Resources (cont.)	-Public health standards tabularized (Table 1-10).	-Standards would probably be more stringent.
	-CDW classes South Platte River as B-1 cold water fishery stream (1977).	
	-Salinity of Colorado River at Cameo, Colorado, is 440 mg/l. Imperial Dam, Arizona, is 861 mg/l (present modified condition).	-Salinity of Colorado River at Cameo, Colorado, 451 mg/l. Imperial Dam, Arizona) 865 mg/l-
Aquatic Resources	Fish Populations: Special extent and distribution tabularized in South Platte River, Waterton Canyon.	
	Bottom Fauna: sampling data in text.	
	Aquatic Vegetation: none	
	Amphibians: species data tabularized (Table 2-24).	Fewer amphibians would be present, but very little change.
Geology, Minerals, and Topography	Topography and General Geology 2 provinces: southern Rocky Mountain and Great Plains.	Topography and General Geology: very little change except normal weathering modifications.
	Geologic Processes: sedimentation.	
	Minerals:	Minerals: USGS (1963) infers uranium and pegmatite minerals may be present in minable quantities.
	-Radium, radon, uranium.	
	-Limestone, clay.	
	Geological Hazards and Problem Areas:	

TABLE 2-31 (cont.)

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (year 1977)	Future Environment (year 2010) Without the Proposed Action
Geology, Minerals, and Topography (cont.)	-Faults, joints, seismic activity, earthquake hazard discussed; not quantifiable.	
	-Slides and rock falls discussed in text; hazard not quantifiable.	
Soils	Soil descriptions are mapped from 3 SCS soil surveys. (Maps 2-2, 2-3 and 2-4)	Soil development, erosion, and deposition would continue as at present; urban expansion in the flat area would decrease productive potential; erosion would increase in the canyon from increased flows and increased recreation.
	Soil descriptions and interpretations and specific soil properties tabularized (Table 2-25) Sediment Yields: 1974 - low yield 0.1-1.2 ac-ft per 640 acres per year (½ ton/ac/yr.) undisturbed; Disturbed - high yield - 1.0 ac-ft per 640 acres per year (3 tons/ac/yr.)	
Terrestrial Resources	Vegetation (1977): 3 vegetative zones, 4 basic plant communities, mapped in text and extent tabularized (Maps 2-5, 2-6, Table 2-26).	
	Summary of Vegetation and Wildlife	
	-Bighorn sheep mapped (Map 2-7).	Recreation pressure would decrease wildlife in the canyon. If sheep were replaced, the range could support 76 head.
	-Endangered species: the southern bald eagle and the peregrine falcon are the only endangered species known to inhabit the project area.	Both species should still be present in the South Platte River System.
	-Peregrine falcon: there is an active eyrie in the South Platte Canyon.	Eyrie would still be used if unmolested and given adequate protection.
	-Other animal species: Golden eagles, mule deer, mountain lion, black bear and elk can be found in the South Platte Canyon.	Would still be present in the canyon if given normal protection.

TABLE 2-31 (cont)

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (year 1977)	Future Environment (year 2010) Without the Proposed Action
Paleontological Resources	Two localities reported nearby study area, plus mammoth skull at Chatfield Dam and Paleocene deposits of vertebrates are considered likely.	The palentological potential would remain the same.
Recreation	Type and extent of recreation utilized discussed and tabularized for--	With continued access, Waterton Canyon visitor pressure would increase; quality would depend on recreation management; Roxborough Park will expand 756 acres for 1,000 recreationists per day.
	-Waterton Canyon (10-20,000 visits in 1976).	South Platte River to Cheesman Reservoir visits would double by 2010: USFS South Platte Planning Unit will be ready in 1980; will expand recreation from 1980-2010.
	-South Platte River to Cheesman Reservoir.	
	-North Fork of the South Platte.	
	Treatment Plant Site	Increasing flows would limit recreation in the South Platte River System.
		Chatfield Dam (1974) and reservoir would produce 1,300 surface acres of water recreation.
Land Use	Waterton Canyon - 1/3 DWB-owned; 2/3 public land (USFS/BLM).	Land use patterns will be similar to the present; patterns will be established by topographic features (Waterton Canyon), man-made feature (Chatfield Dam and Reservoir) and land use trends to intensive residential development (see maps).
	Denver expanding metro area.	
	Small rural communities.	
	Large and grazing holdings.	Utilities and road would be upgraded by 73 acres annual aereal development near the conduits and 0.1 miles annually
	Chatfield dam (1975).	

TABLE 2-31 (Cont.)

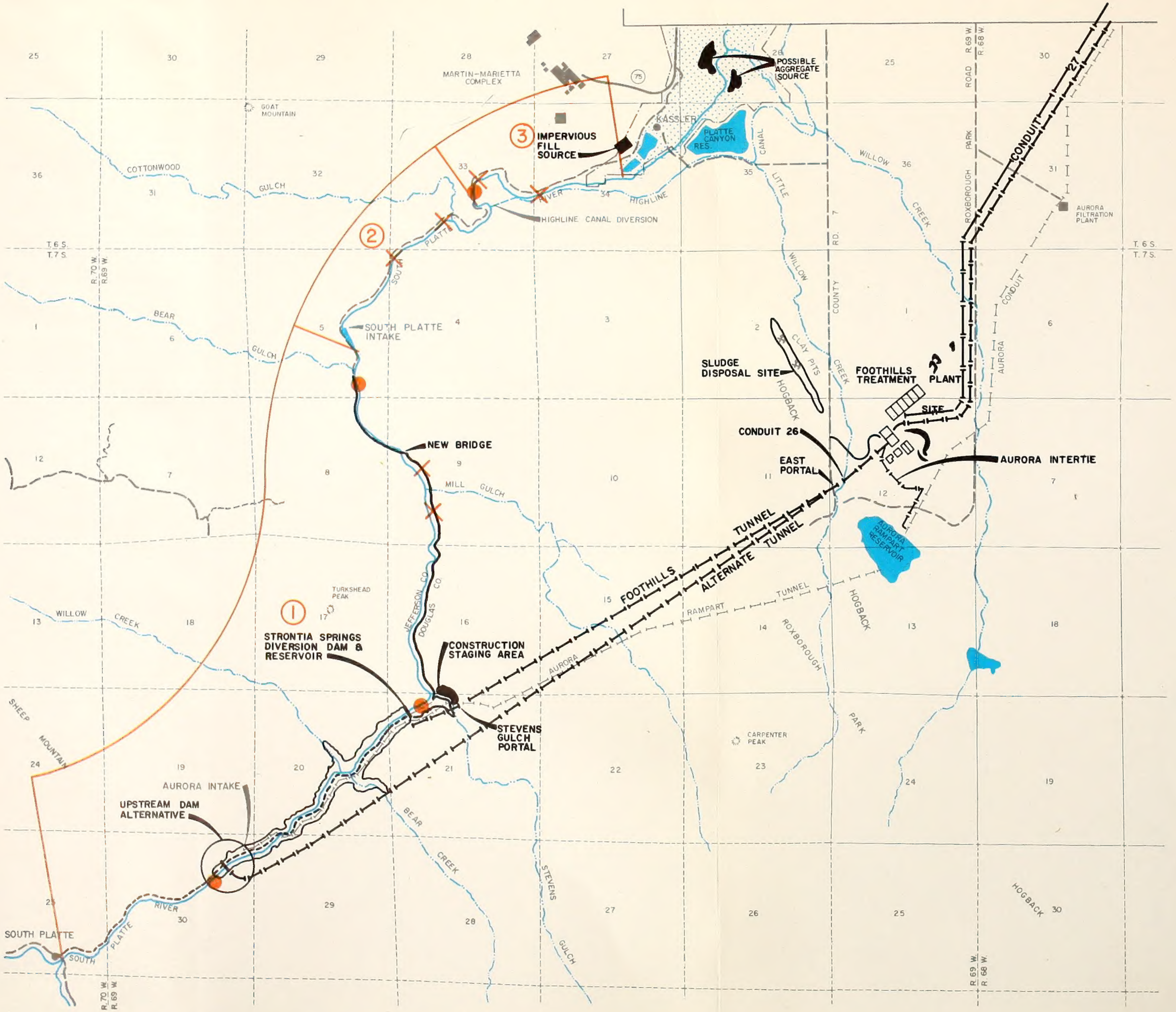
SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (year 1977)	Future Environment (year 2010) Without the Proposed Action
Land Use (cont.)	Discussion of Roads (traffic volume tabularized).	
	Air traffic.	
Climate and Air Quality	Temperature - relation to altitude; average 45^{o}-50^{o}F extremes of -$35^{o}$to 40°F in winter to 100^{o} F summer.	Temperature would remain the same.
	Precipitation: May highest month (2.75"); average annual precipitation 16".	Precipitation would not change
	Ambient Moisture and Evaporation: ambient levels low, 15"-24" per year pan evaporation.	Moisture and evaporation would stay the same.
	Winds: no data in area; Denver prevailing wind south, 9.3 mph.	Winds would not change.
	Air Pollution: no data, but total suspended particulates occasionally exceeded by fugitive dust.	Overall air pollution would increase with urbanization increasing in or near the project area. No data available described precisely how this urbanization increase would occur. Water supply with the attendant loss of horticulture, there would have to occur a marked increase in airborne particulate matter (fugitive dust).
Noise	32-40 dBA low noise level.	Noise levels would remain the same.
Visual Resources	Visual elements discussed, rated, mapped and picture.	Increased recreational use, and additional and additional developments would reduce visual integrity.

TABLE 2-31 (cont.)

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (year 1977)	Future Environment (year 2010) Without the Proposed Action
Cultural Resources Archaeological Resources	Archaeological potential discussed from data available for 1977	Archaeological resources would evidence collecting and digging, as well as destruction through urban expansion.
Historical Resources	Historical sites tabularized; 106 protection listed.	Deansbury Station and Strontia Springs sites should remain the same; railroad grades, cuts and rockwork should remain the same.



AQUATIC RESOURCES

LEGEND

3 STUDY AREA

AMPHIBIAN POND

FISH SAMPLING STATION

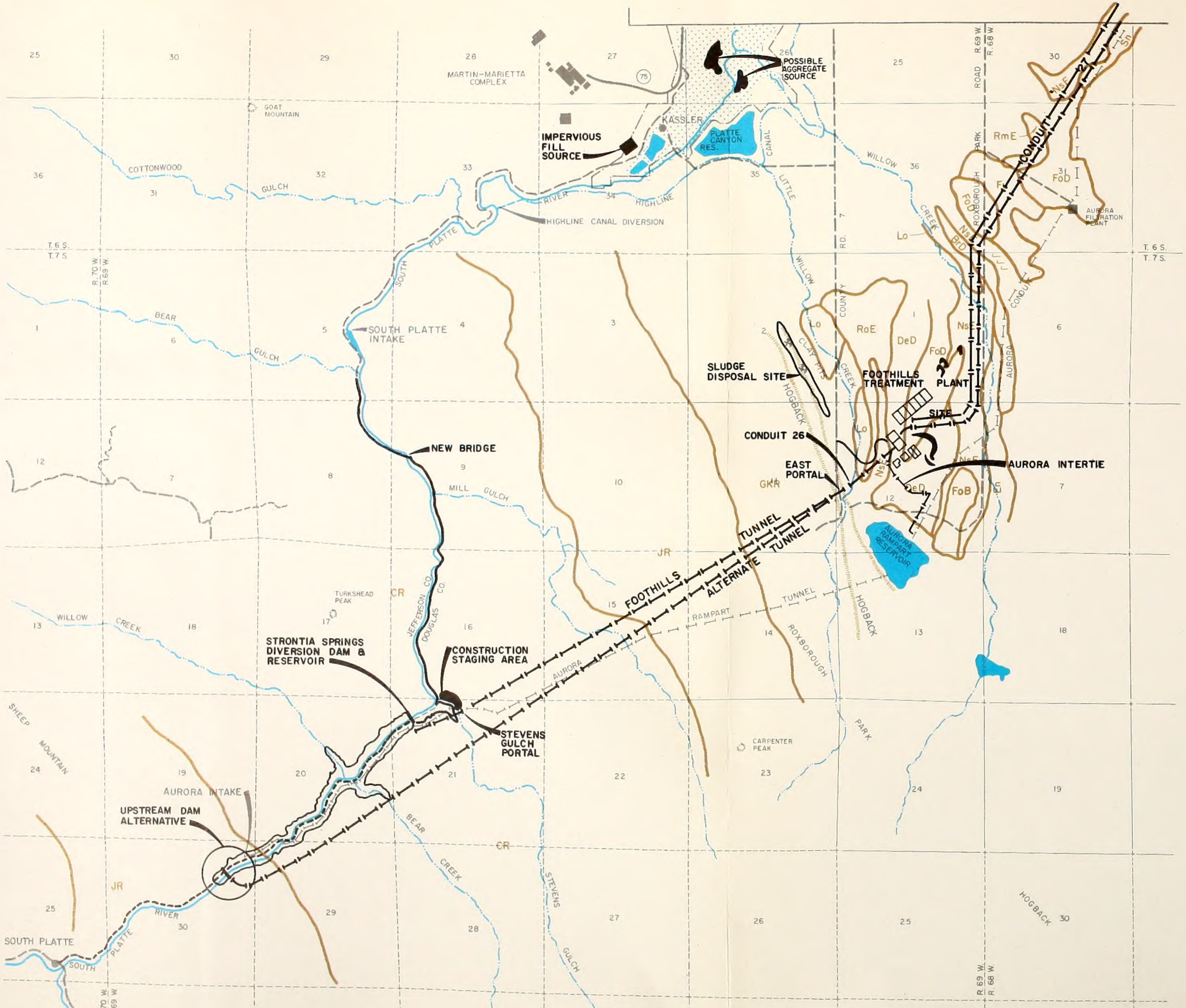
N

0 1000' 2000' 4000' 6000'

DESCRIPTION OF THE ENVIRONMENT

TOPOGRAPHIC MAP - FOOTHILLS

MAP 2-1



SOILS

Legend — Douglas Co. (Castle Rock Survey Area)

Map Symbol	Soil Unit
*BrB	Bresser sandy loam, (1-3% slopes)
BrD	Bresser sandy loam, (3-9% slopes)
DeD	Denver clay loam, (5-12% slopes)
En	Englewood clay loam, (1-4% slopes)
FoD	Fondis clay loam, (3-9% slopes)
*FdB	Fondis silt loam, (1-3% slopes)
*FdC	Fondis silt loam, (3-5% slopes)
FoB	Fondis clay loam, (1-3% slopes)
Lo	Loamy alluvial land, (1-5% slopes)
RaE	Razor clay, (3-25% slopes)
*Sn	Satanta loam, (1-4% slopes)
Fu	Fondis-Kutch
NsE	Newlin-Satanta complex, (8-30% slopes)
RmE	Renohill-Buick complex, (5-25% slopes)

General Soil Associations

GKR	Garber-Kassler-Rockland
JR	Juget-Rockland
CR	Cryoboralf-Rock Outcrop
///	Outcropping

*Prime Agricultural Soils (Regional Classification)
Hill, Gayle. Denver Regional Council of Governments. Criteria for Specification of Primary Agricultural Lands, November, 1976 (Draft)
Prime agricultural lands are classified as the most productive lands in this region, irrigated or non-irrigated.

DESCRIPTION OF THE ENVIRONMENT

MAP - FOOTHILLS

MAP 2-2

SOILS

Legend	Arapahoe Co. Soil Survey
Map Symbol	**Soil Unit**
* FdB	Fondis silt loam, (1-3% slopes)
* FoC	Fondis-Colby complex, (3-5% slopes)
Lo	Loamy alluvial land, (1-5% slopes)
RhD	Renohill-Buick, (3-9% slopes)
RtE	Renohill loam, (9-20% slopes)
Tc	Terrace Escarpment
—	**Douglas Co. (Castle Rock Survey Area)**
BiE	Blakeland sandy loam, (1-15% slopes)
* BrB	Bresser sandy loam, (1-3% slopes)
BrD	Bresser sandy loam, (3-9% slopes)
BsE	Bresser-Louviers complex, (7-30% slopes)
BwD	Buick-Satanta loam, (3-9% slopes)
Lo	Loamy alluvial land, (1-5% slopes)
Se	Sandy wet alluvium, (1-5% slopes)
* Sn	Satanta loam, (1-4% slopes)
NeE	Newlin gravelly sandy loam, (8-30% slopes)
NsE	Newlin-Satanta complex, (5-20% slopes)
* TrB	Truckton sandy loam, (1-3% slopes)
TrD	Truckton sandy loam, (3-8% slopes)
	Douglas Co. Phipps Ranch portion (Golden Soil Survey Area)
6A	Fluventic Haplustoll, loamy, (0-2% slopes)
16C	Ulm clay loam, calcareous surface, (5-9% slopes)
24E	Renohill-Buick clay loam, (9-15% slopes)
30R	Ulm-Renohill clay loam, (9-15% slopes)
* 35A	Fondis clay loam, (0-3% slopes)
35B	Fondis clay loam, (3-9% slopes)
35L	Fondis loam, (3-9% slopes)
* 36B	Blakeland loamy sand, (0-3% slopes)
36X	Blakeland-Orsa complex, (9-15% slopes)
37B	Truckton loamy sand, (3-9% slopes)
* 37S	Truckton sandy loam, (3-9% slopes)

* Prime Agricultural Soils (Regional Classification)

Hill, Gayle. Denver Regional Council of Governments. Criteria for Specifications of Primary Agricultural Lands, November, 1976 (Draft). Prime Agricultural Lands are classified as the most productive lands in this region, irrigated or non-irrigated.

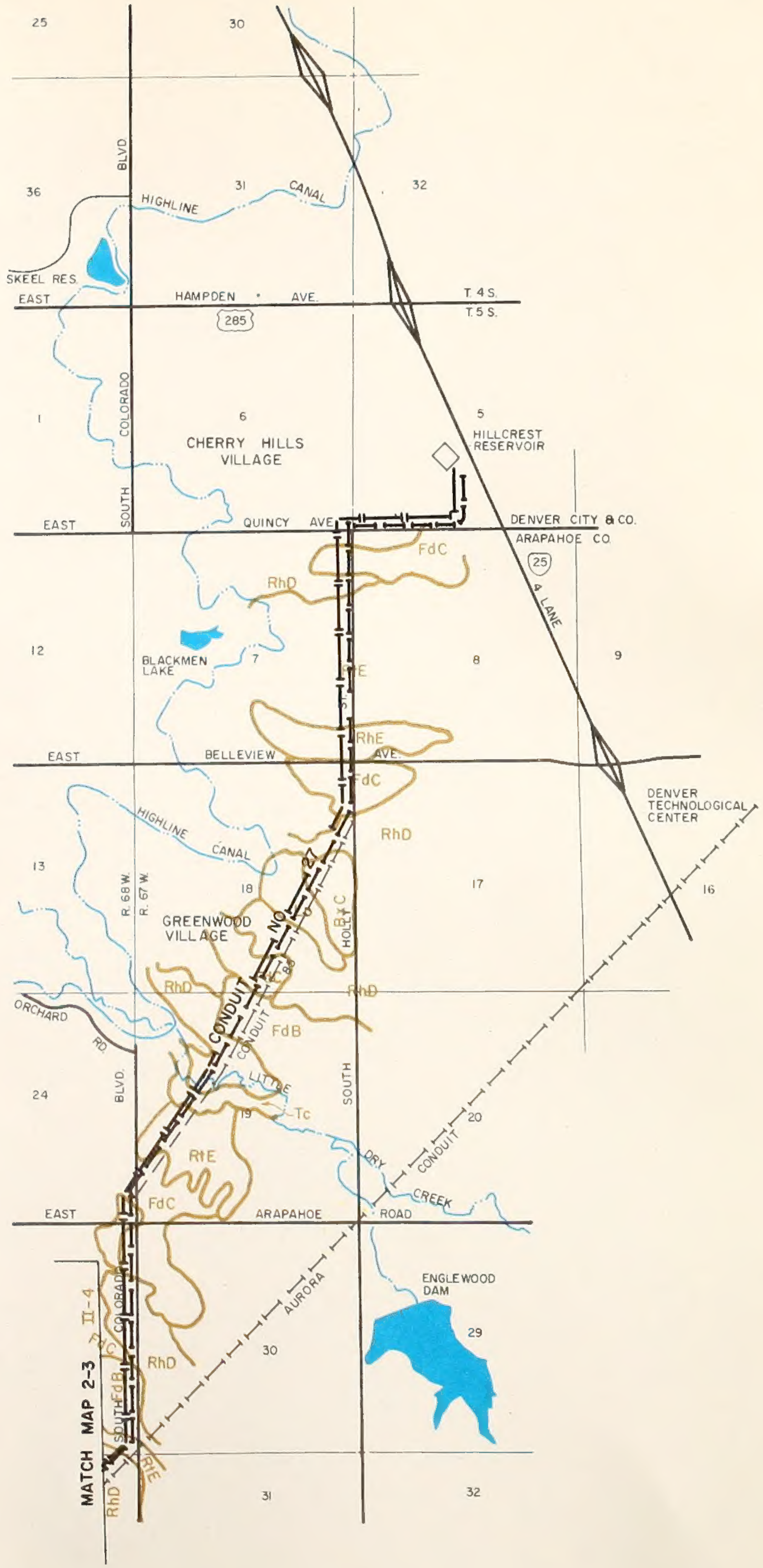
N

0 1000' 2000' 4000' 6000'

DESCRIPTION OF THE ENVIRONMENT

MAP - HIGHLANDS RESERVOIR

MAP 2-3



SOILS

Legend	Arapahoe Co. Soil Survey
Map Symbol	**Soil Unit**
BxC	Buick loam, (3-5% slopes)
*FdB	Fondis silt loam, (1-3% slopes)
*FdC	Fondis silt loam, (3-5% slopes)
Lo	Loamy alluvial land, (1-5% slopes)
RhD	Renohill-Buick, (3-9% slopes)
RhE	Renohill loam, (9-20% slopes)
RtE	Renohill-Litle-Thedalund, (9-30% slopes)
Tc	Terrace Escarpment

*Prime Agricultural Soils (Regional Classification)
Hill, Gayle. Denver Regional Council of Governments.
Criteria for Specification of Primary Agricultural Lands,
November, 1976 (Draft)
Prime agricultural lands are classified as the most productive lands in this region, irrigated or non-irrigated.

N

0 1000' 2000' 4000' 6000'

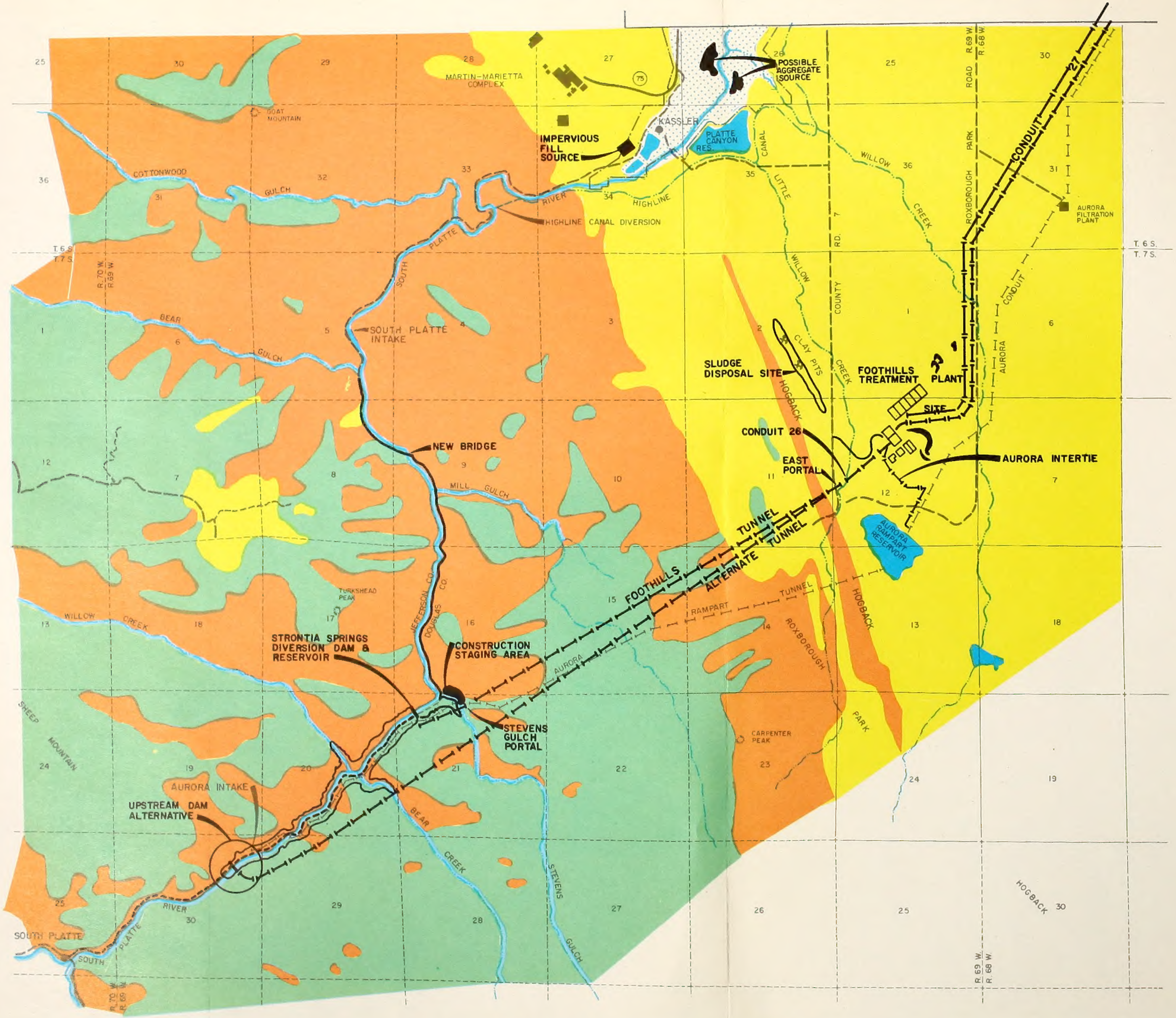
DESCRIPTION OF THE ENVIRONMENT

MAP - HILLCREST RESERVOIR

MAP 2-4

DESCRIPTION OF THE ENVIRONMENT

MAP 2-5



TERRESTRIAL RESOURCES

VEGETATION

- BRUSH
- FOREST
- GRASSLAND
- RIPARIAN

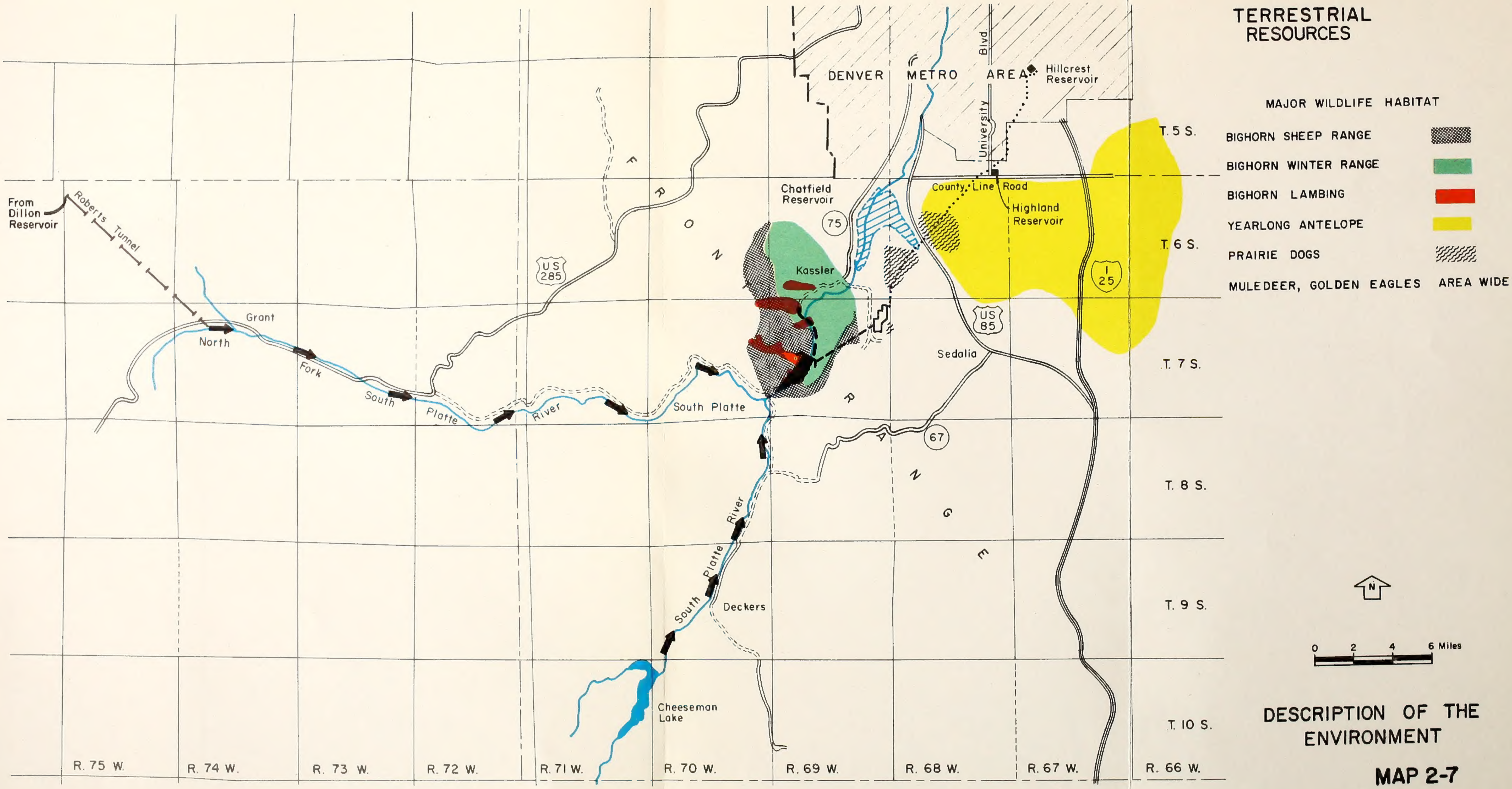
N

0 1000' 2000' 4000' 6000'

DESCRIPTION OF THE ENVIRONMENT

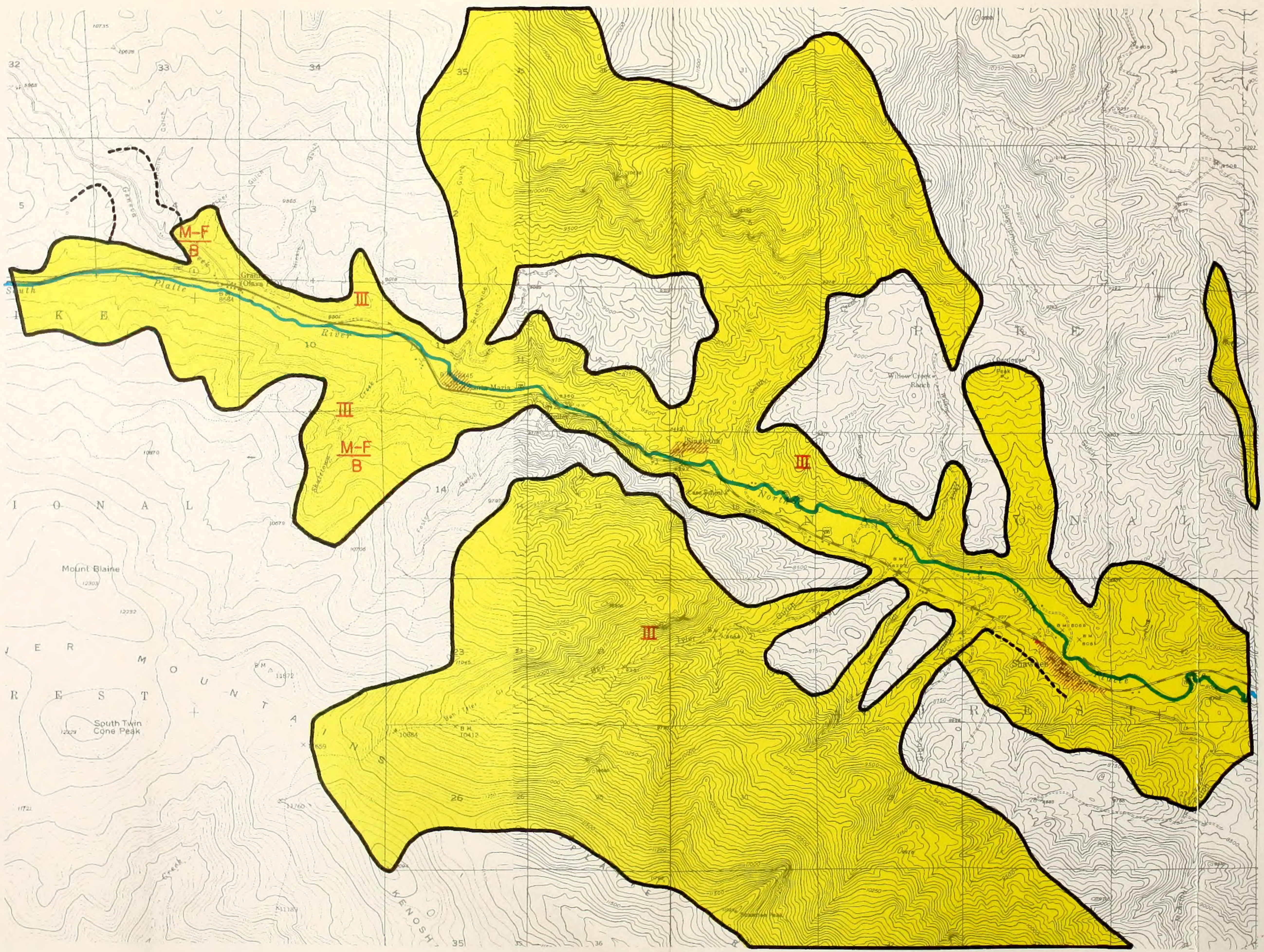
TOPOGRAPHIC MAP - FOOTHILLS

MAP 2-6



DESCRIPTION OF THE ENVIRONMENT

MAP 2-7



VISUAL RESOURCES

LEGEND

X-X / X = SENSITIVITY - VIEWING DISTANCE / SCENIC QUALITY

M — MODERATE SENSITIVITY
L — LOW SENSITIVITY
F — FOREGROUND (VIEWING DISTANCE)
MG — MIDDLE GROUND (VIEWING DISTANCE)
B — CHARACTERISTIC SCENERY: CLASS B
III — VISUAL MANAGEMENT CLASS III: ALLOWS 16 POINTS OF CONTRAST
VISUAL MANAGEMENT CLASS IV: ALLOWS 20 POINTS OF CONTRAST

VIEWSHED BOUNDARY (VISUAL CORRIDOR)
SENSITIVE FEATURE

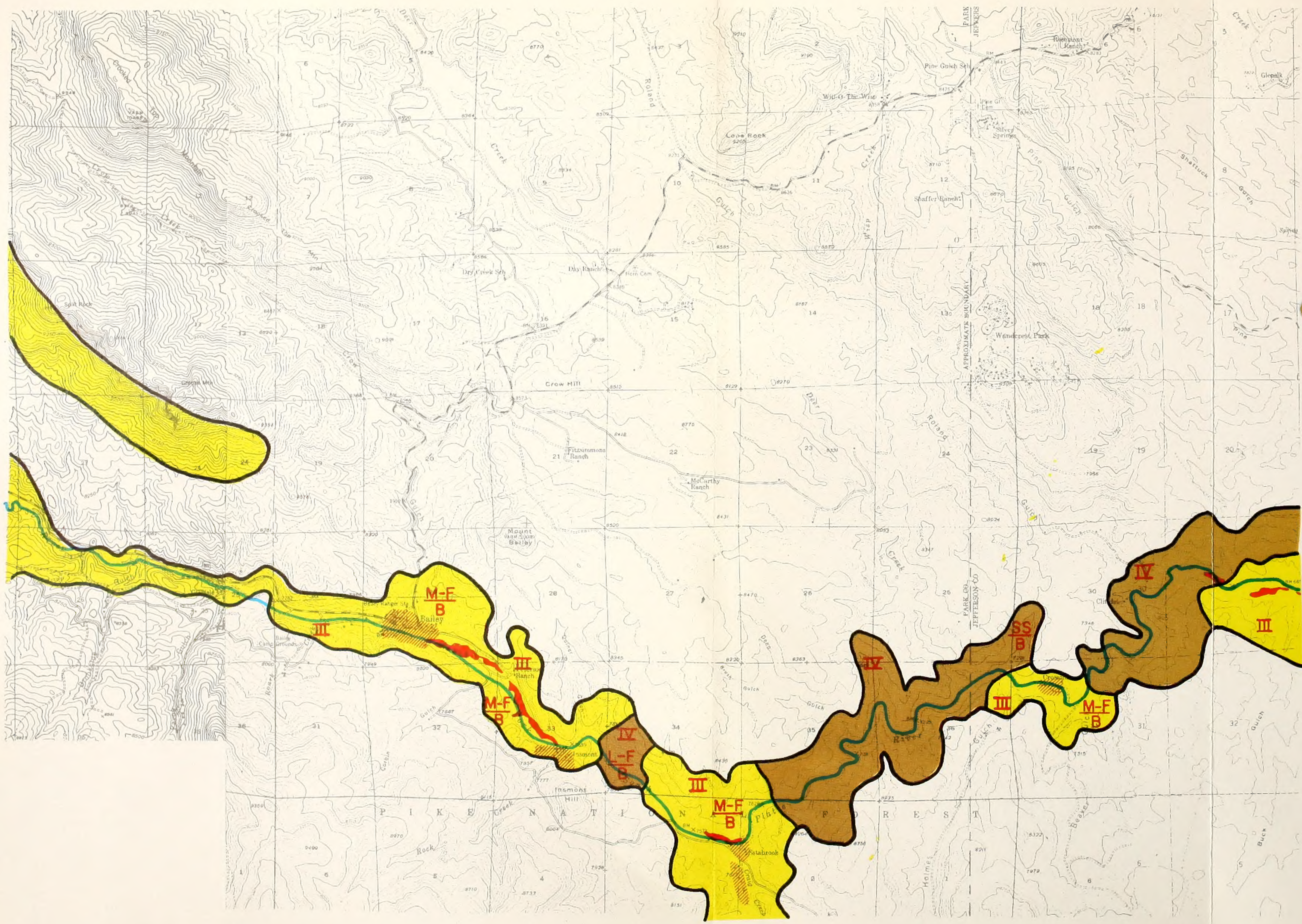
UNSHADED AREAS ARE NOT CLASSIFIED

N

0 2000 4000 6000

DESCRIPTION OF THE ENVIRONMENT

MAP 2-8



VISUAL RESOURCES

LEGEND

$\frac{X-X}{X}$ = SENSITIVITY - VIEWING DISTANCE / SCENIC QUALITY

- M — MODERATE SENSITIVITY
- L — LOW SENSITIVITY
- F — FOREGROUND (VIEWING DISTANCE)
- MG — MIDDLE GROUND (VIEWING DISTANCE)
- B — CHARACTERISTIC SCENERY: CLASS B
- III — VISUAL MANAGEMENT CLASS III: ALLOWS 16 POINTS OF CONTRAST
- IV — VISUAL MANAGEMENT CLASS IV: ALLOWS 20 POINTS OF CONTRAST
- VIEWSHED BOUNDARY (VISUAL CORRIDOR)
- SENSITIVE FEATURE
- FLOODING AREAS AT 1020 c.f.s.

UNSHADED AREAS ARE NOT CLASSIFIED

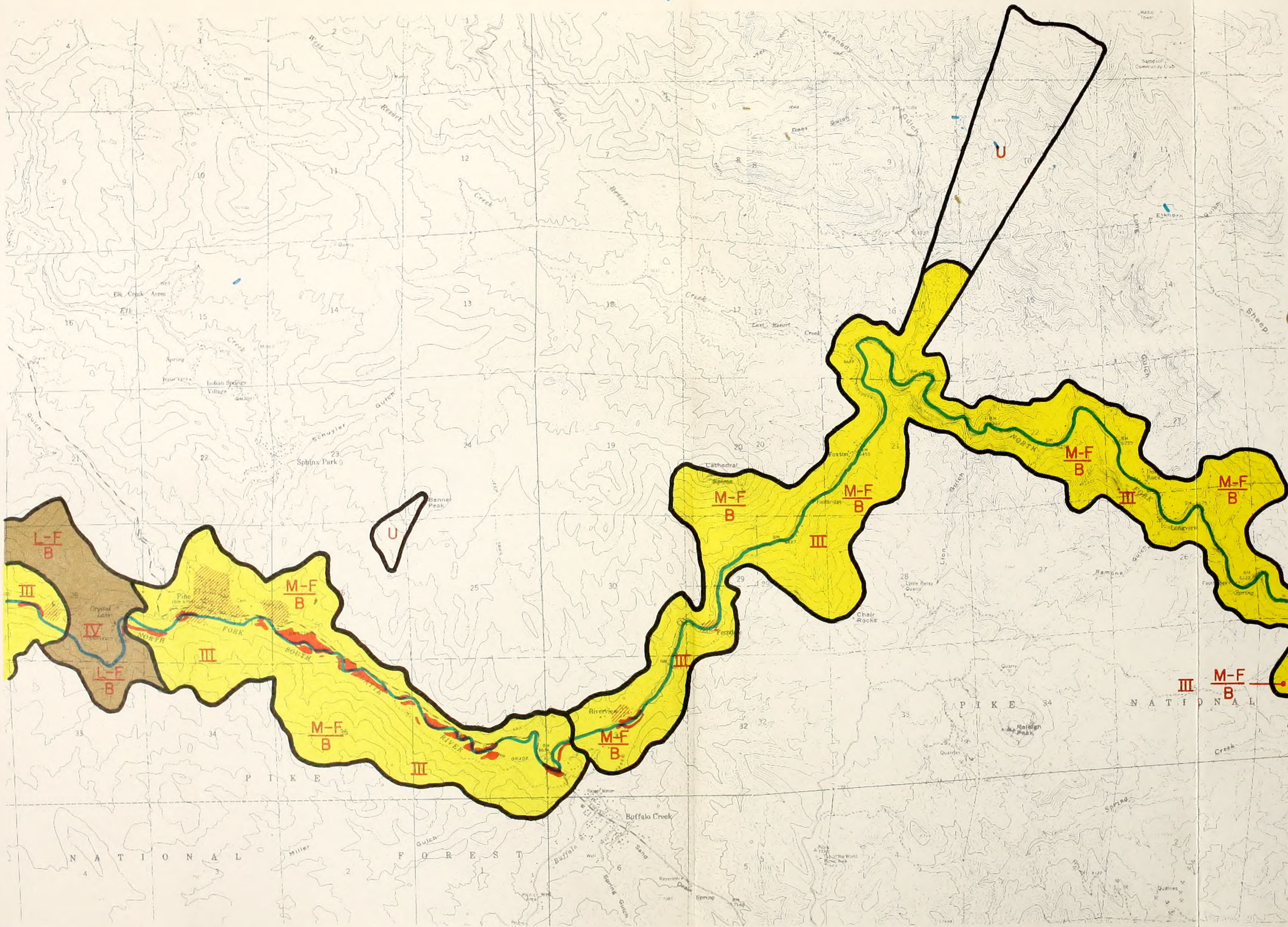
N

0 2000 4000 6000

DESCRIPTION OF THE ENVIRONMENT

MAP 2-9

VISUAL RESOURCES



LEGEND

$\frac{X-X}{X}$ = $\frac{\text{SENSITIVITY - VIEWING DISTANCE}}{\text{SCENIC QUALITY}}$

M MODERATE SENSITIVITY
L LOW SENSITIVITY
F FOREGROUND (VIEWING DISTANCE)
MG MIDDLE GROUND (VIEWING DISTANCE)
B CHARACTERISTIC SCENERY: CLASS B
III VISUAL MANAGEMENT CLASS III: ALLOWS 16 POINTS OF CONTRAST
IV VISUAL MANAGEMENT CLASS IV: ALLOWS 20 POINTS OF CONTRAST
U UNCLASSIFIED VISUAL CORRIDOR
VIEWSHED BOUNDARY (VISUAL CORRIDOR)
SENSITIVE FEATURE
FLOODING AREAS AT 1020 c.f.s.

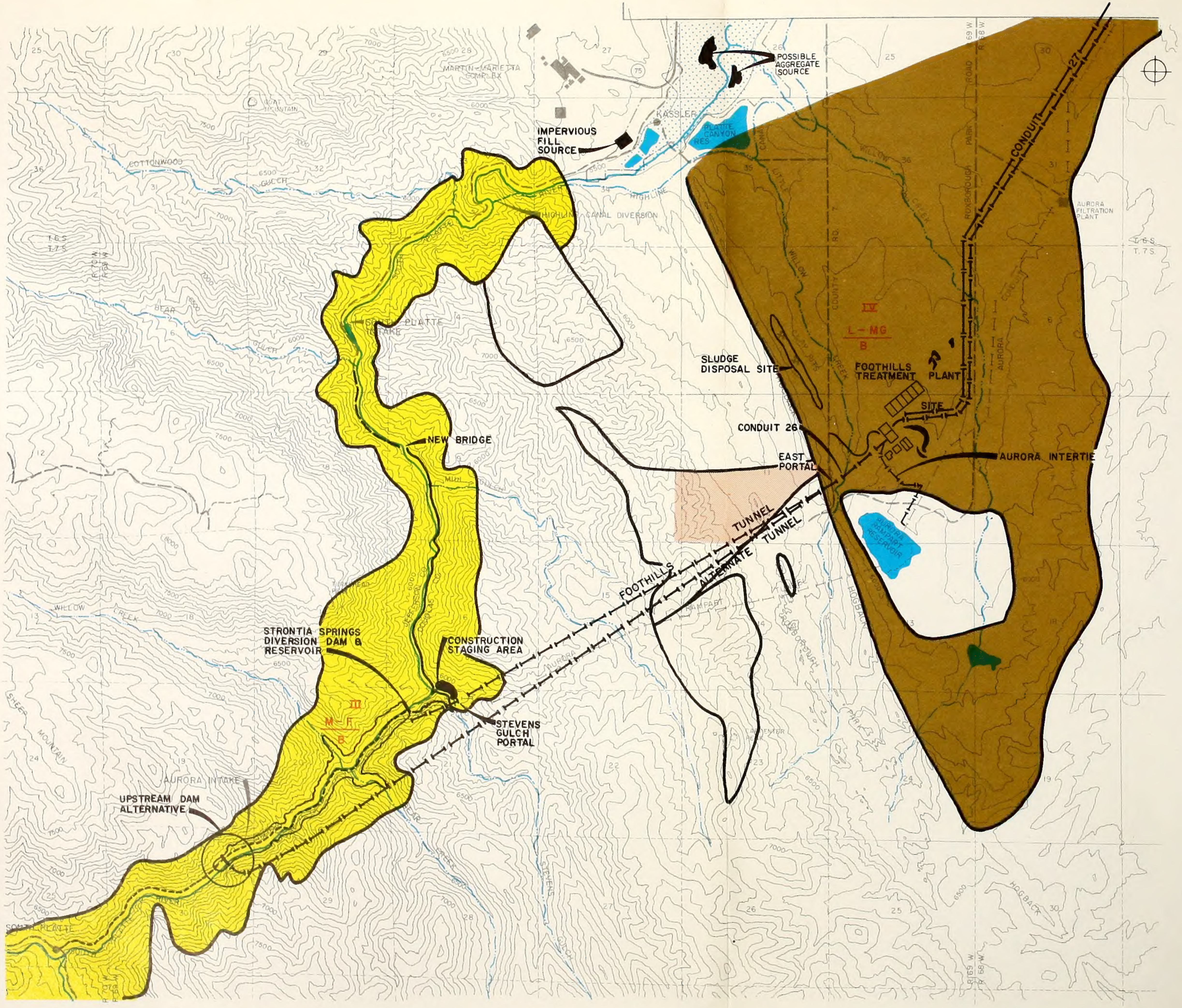
UNSHADED AREAS ARE NOT CLASSIFIED

N

0 2000 4000 6000

DESCRIPTION OF THE ENVIRONMENT

MAP 2-10



VISUAL RESOURCES

LEGEND

X-X SENSITIVITY-VIEWING DISTANCE
X SCENIC QUALITY

M MODERATE SENSITIVITY
L LOW SENSITIVITY
F FOREGROUND (VIEWING DISTANCE)
MG MIDDLE GROUND (VIEWING DISTANCE)
B CHARACTERISTIC SCENERY: CLASS B
III VISUAL MANAGEMENT CLASS III: ALLOWS 16 POINTS OF CONTRAST
IV VISUAL MANAGEMENT CLASS IV: ALLOWS 20 POINTS OF CONTRAST

VIEWSHED BOUNDARY (VISUAL CORRIDOR)
SENSITIVE FEATURE
FLOODING AREAS AT 1020 c.f.s.

UNSHADED AREAS ARE NOT CLASSIFIED

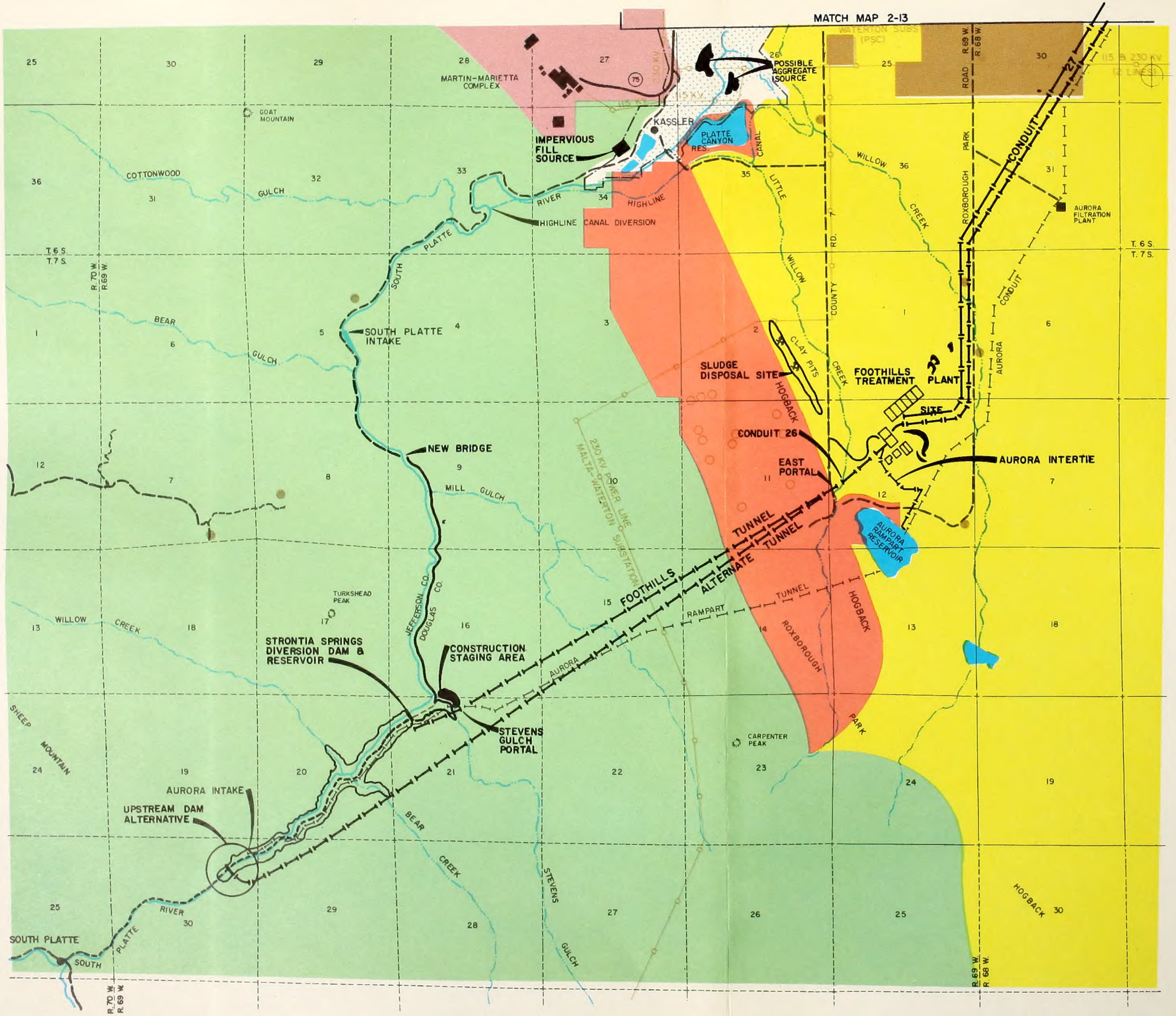
N

0 1000' 2000' 4000' 6000'

DESCRIPTION OF THE ENVIRONMENT

MAP-FOOTHILLS

MAP 2-11



LAND USE

GENERAL LAND USE

- RANGELAND
- DRY FARMLAND
- FOREST & WOODLAND
- UNDEVELOPED AREAS, OPEN SPACE
- LIGHT INDUSTRIAL, COMMERCIAL
- INDIVIDUAL DWELLINGS OR FARMSTEADS IN THE VICINITY OF THE PROJECT.
- RESIDENCES OR CONDOMINIUMS IN SOME STAGE OF CONSTRUCTION AS PART OF ROXBOROUGH PARK PLANNED COMMUNITY DEVELOPMENT.
- MAJOR POWER TRANSMISSION LINES
- CHATFIELD RESERVOIR AREA

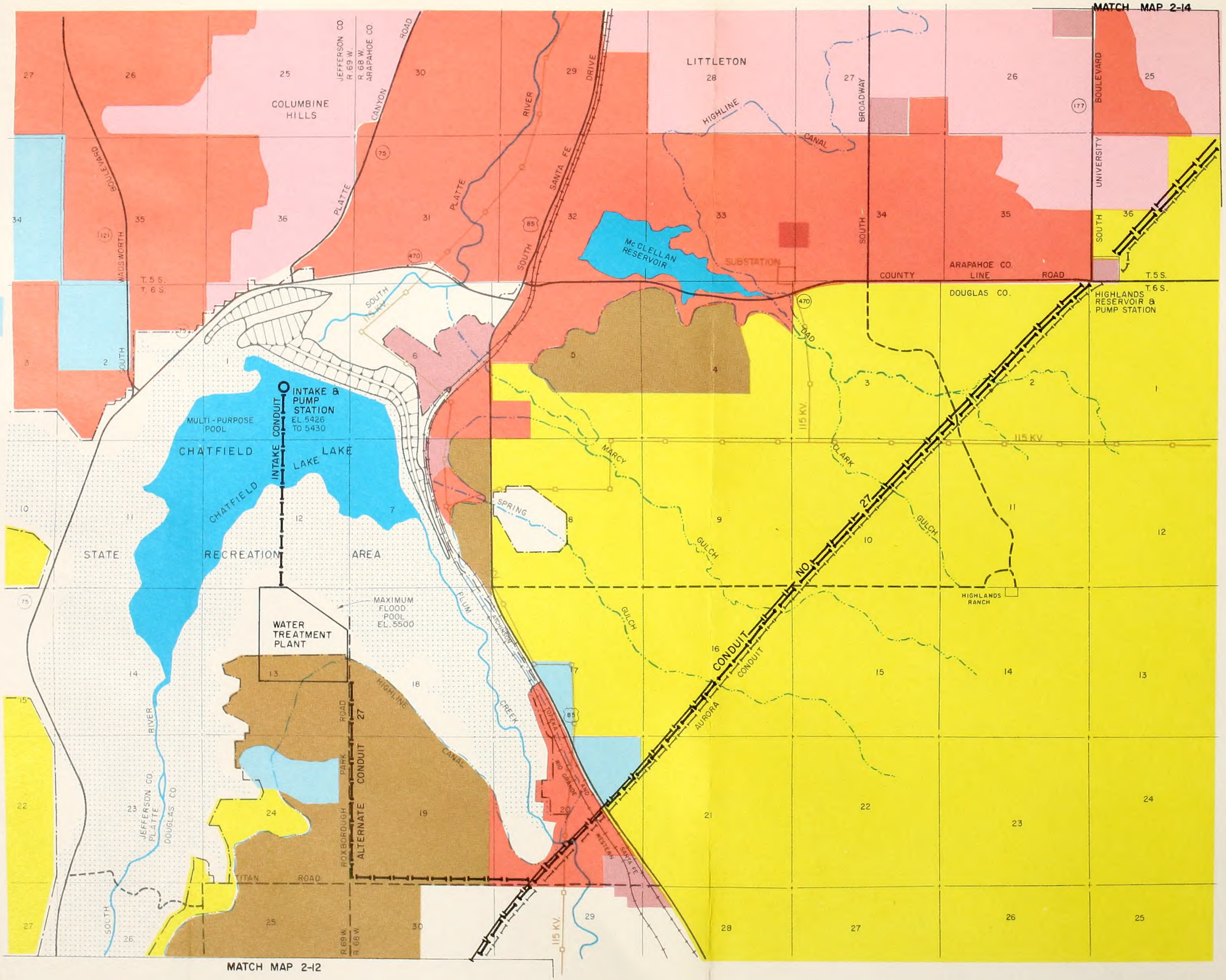
N

0 1000' 2000' 4000' 6000'

DESCRIPTION OF THE ENVIRONMENT

TOPOGRAPHIC MAP - FOOTHILLS

MAP 2-12



LAND USE

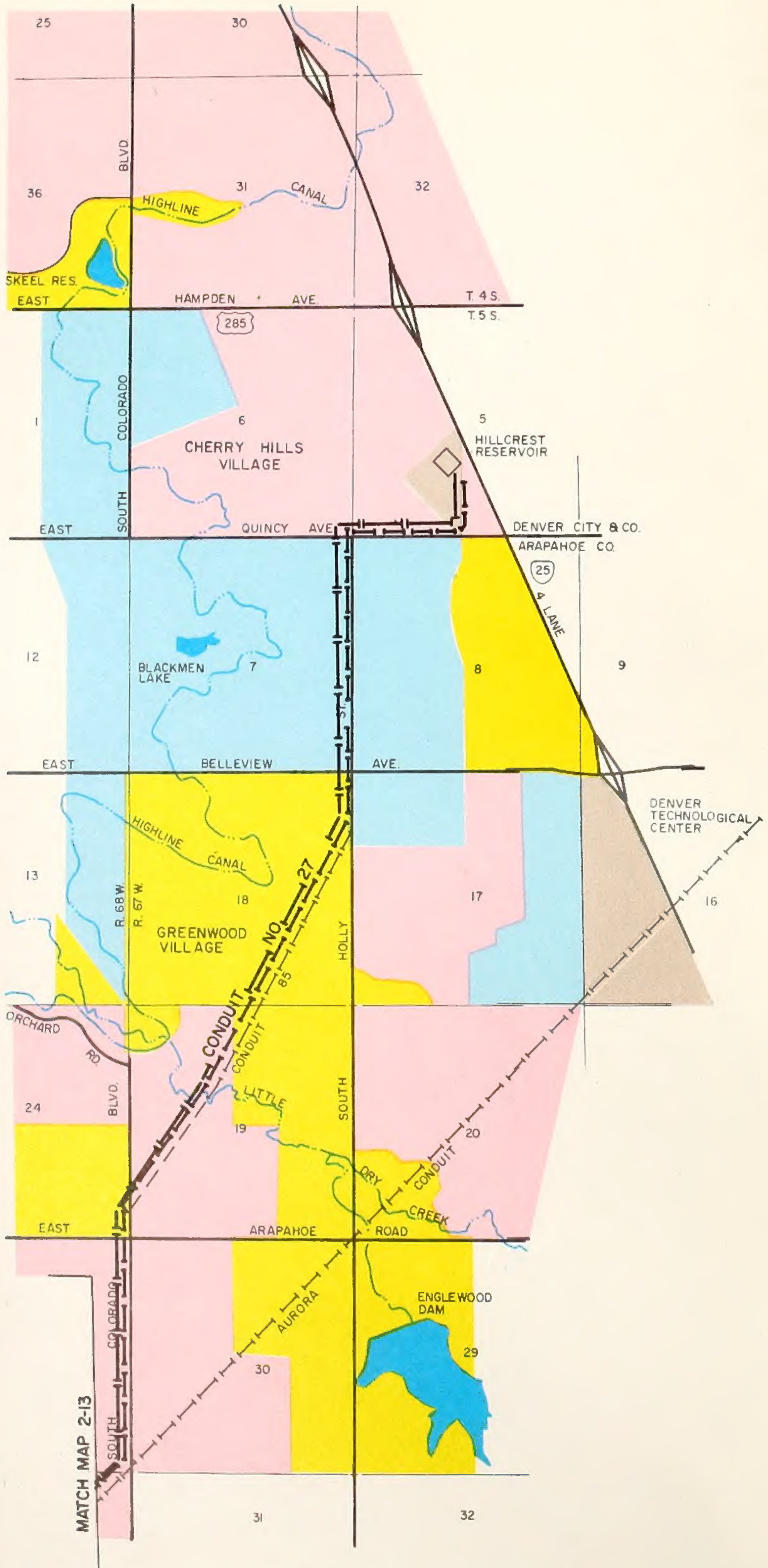
GENERAL LAND USE

- RANGELAND
- DRY FARMLAND
- UNDEVELOPED AREAS, OPEN SPACE
- LIGHT INDUSTRIAL, COMMERCIAL
- LOW DENSITY RESIDENTIAL DEVELOPMENT
- MODERATE DENSITY RESIDENTIAL DEVELOPMENT
- CHATFIELD RESERVOIR AREA
- MAJOR POWER TRANSMISSION LINES

DESCRIPTION OF THE ENVIRONMENT

TOPOGRAPHIC MAP - HIGHLANDS RESERVOIR

MAP 2-13



LAND USE

GENERAL LAND USE

UNDEVELOPED AREAS, OPEN SPACE

LIGHT INDUSTRIAL, COMMERCIAL

LOW DENSITY RESIDENTIAL DEVELOPMENT

MODERATE DENSITY RESIDENTIAL DEVELOPMENT

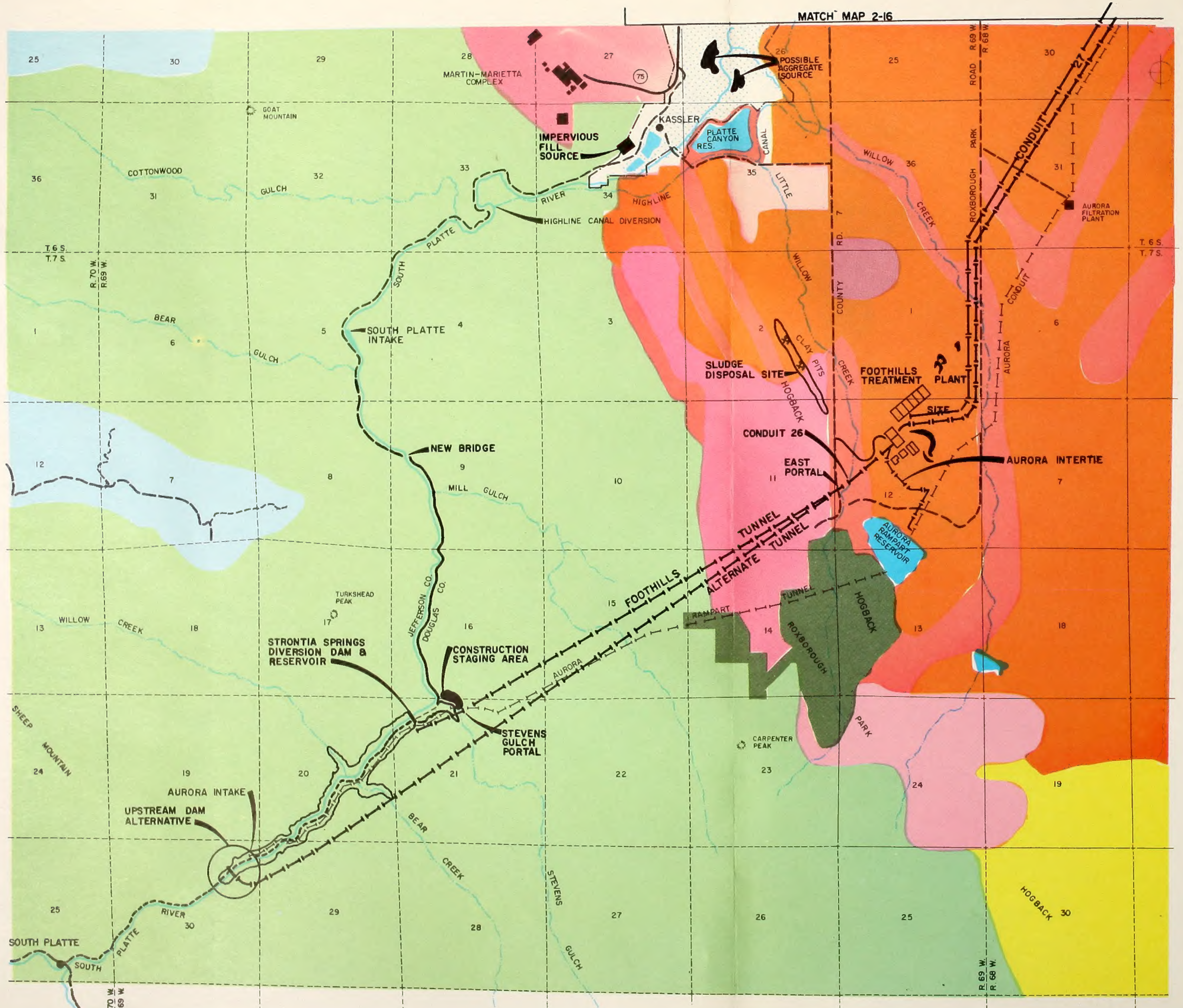
N

0 1000' 2000' 4000' 6000'

DESCRIPTION OF THE ENVIRONMENT

TOPOGRAPHIC MAP - HILLCREST RESERVOIR

MAP 2-14



LAND USE - FUTURE

GENERAL LAND USE

- MAJOR ACTIVITY - EMPLOYMENT CENTERS (DOUGLAS COUNTY)
- LIGHT INDUSTRIAL
- NEW COMMUNITIES OR VILLAGES 0-2.5 DWELLING UNITS PER GROSS ACRE (DOUGLAS COUNTY)
- AGRICULTURAL SUBDIVISIONS 0-1 DWELLING UNIT PER TEN ACRES (DOUGLAS COUNTY)
- LOW MOUNTAIN DENSITY RESIDENTIAL (JEFFERSON COUNTY)
- CHATFIELD RESERVOIR AND STATE RECREATION AREA
- ROXBOROUGH STATE PARK
- GRAZING LAND
- FOREST AND WOODLAND
- UNDEVELOPED AREAS, OPEN SPACE, PASTURE

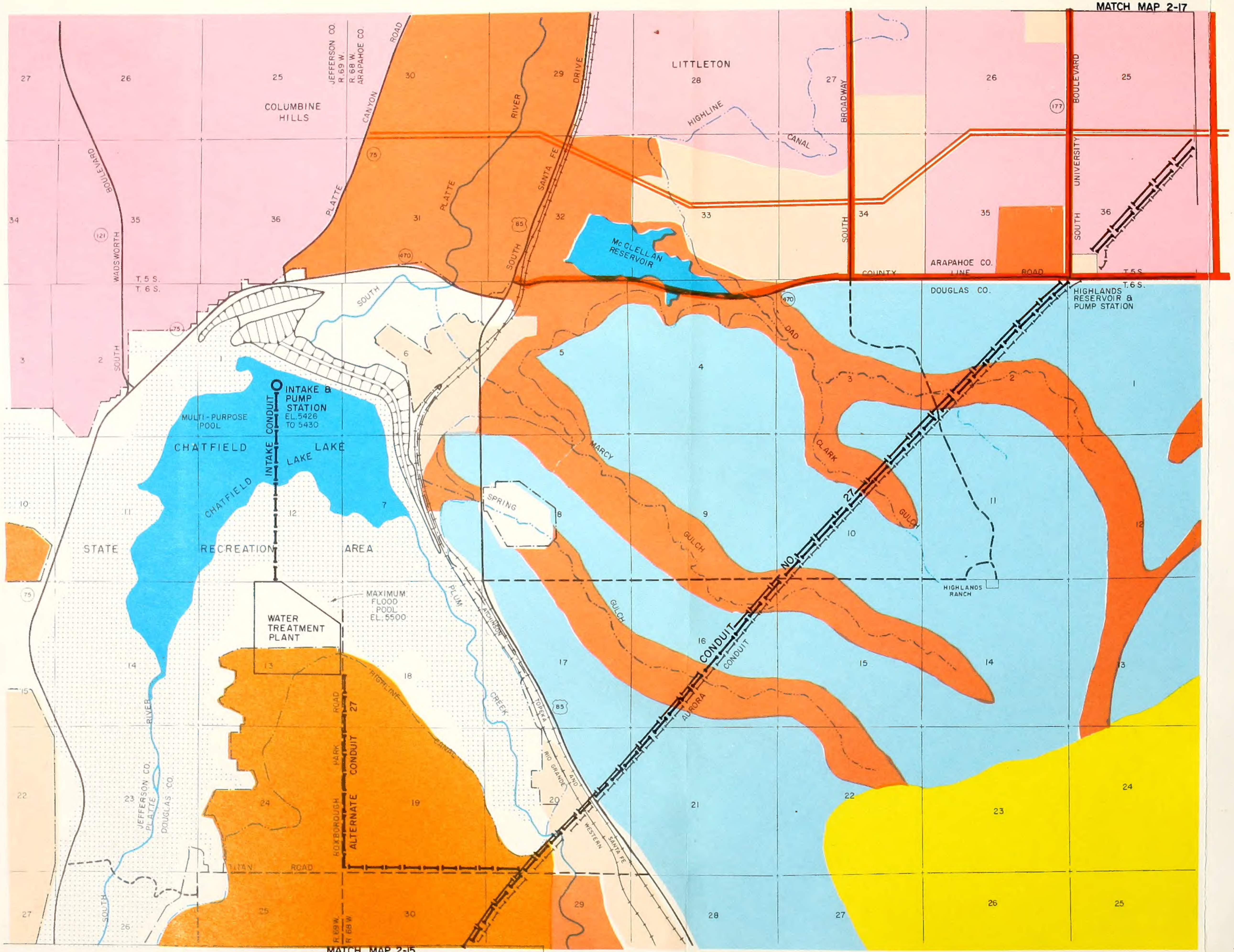
N

0 1000' 2000' 4000' 6000'

DESCRIPTION OF FUTURE ENVIRONMENT WITHOUT THE PROPOSED ACTION

TOPOGRAPHIC MAP - FOOTHILLS

MAP 2-15



LAND USE - FUTURE

GENERAL LAND USE

- LIGHT INDUSTRIAL
- MODERATE DENSITY RESIDENTIAL DEVELOPMENT
- AGRICULTURAL SUBDIVISIONS 0-1 DWELLING UNITS PER ACRE
- AGRICULTURAL SUBDIVISIONS 0-1 DWELLING UNITS PER 10 ACRES
- RANGELAND
- UNDEVELOPED AREAS, OPEN SPACE, PASTURE
- PARKWAY
- MAJOR ARTERIAL ROADWAYS
- CHATFIELD RESERVOIR AND STATE RECREATION AREA

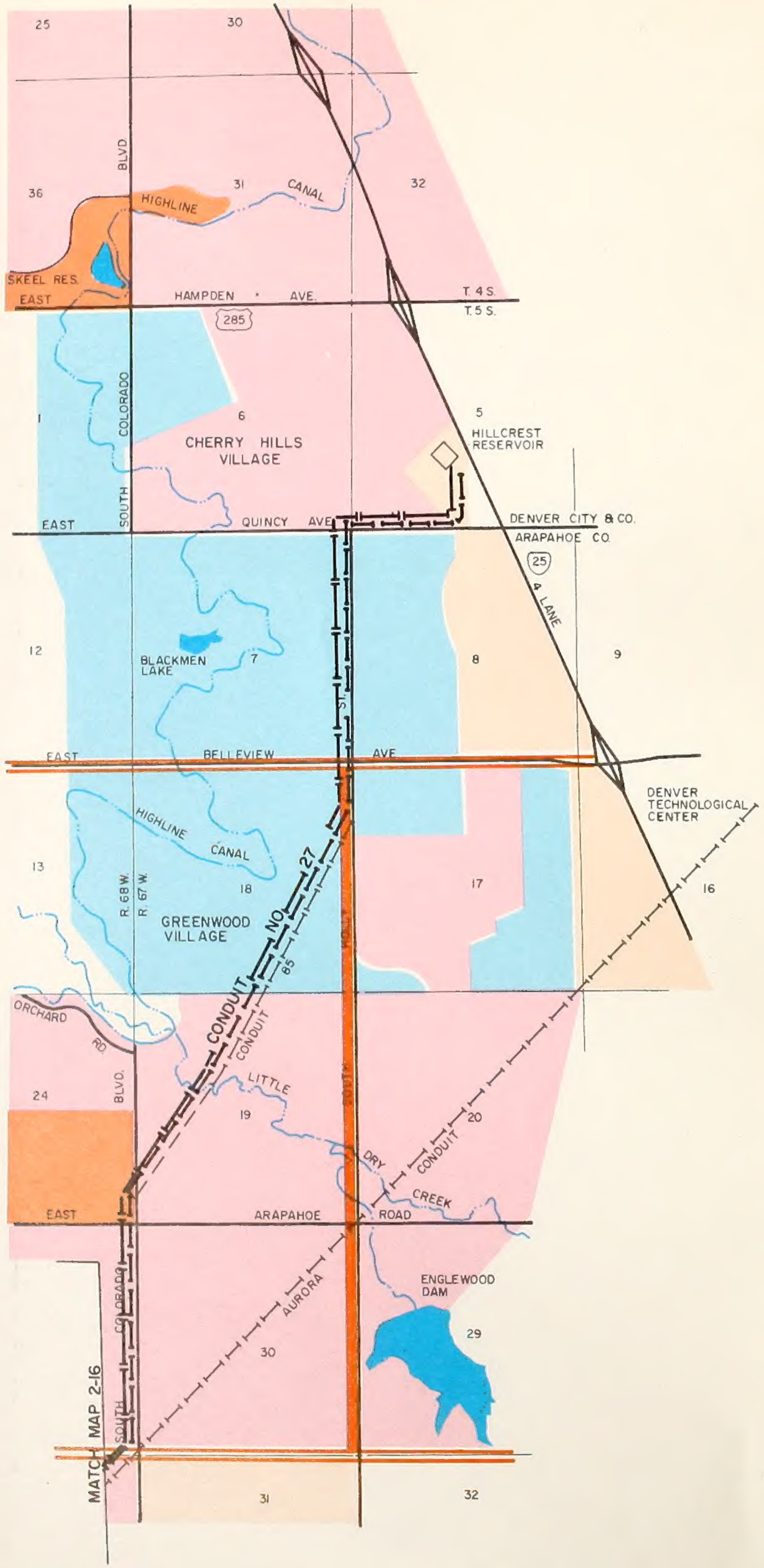
N

0 1000' 2000' 4000' 6000'

DESCRIPTION OF FUTURE ENVIRONMENT WITHOUT THE PROPOSED ACTION

TOPOGRAPHIC MAP - HIGHLANDS RESERVOIR

MAP 2-16



LAND USE - FUTURE

GENERAL LAND USE

- LIGHT INDUSTRIAL, COMMERCIAL
- LOW DENSITY RESIDENTIAL DEVELOPMENT
- MODERATE DENSITY RESIDENTIAL DEVELOPMENT
- OPEN SPACE
- MAJOR ARTERIAL ROADWAYS
- PARKWAYS

N

0 1000' 2000' 4000' 6000'

DESCRIPTION OF FUTURE ENVIRONMENT WITHOUT THE PROPOSED ACTION

TOPOGRAPHIC MAP - HILLCREST RESERVOIR

MAP 2-17

Chapter 3

Environmental Impact of the Proposed Action

CHAPTER 3

ENVIRONMENTAL IMPACTS OF THE PROPOSAL

This chapter identifies and analyzes impacts of the proposed Foothills Project. Each impact is analyzed in a cause and effect manner; secondary impacts are identified and traced as far as practical.

The cause identified is tied to a component of the project proposal (Chapter 1) and the effect identified is tied to a component of the environment (Chapter 2). Existing environmental data were used to assess temporary or short-term impacts, while both existing and projected future environmental data were used to assess permanent or long-term impacts.

ASSUMPTIONS AND ANALYSIS GUIDELINES

Impacts on the environment if the proposal is implemented will be analyzed using the following assumptions:

1. Impacts will be analyzed considering two levels of operation of the Foothills Treatment Plant: 125 mgd (million gallons per day) and 500 mgd.

2. Implementation would be three years from the granting of the rights-of-way permit for the 125 mgd plant, assumed here to be May of 1978; operational impacts would begin at that point. Construction impacts would begin shortly after issuance of necessary permits. Based on current population and use trends, it is assumed that expansion to 500 mgd would begin before 2001 since the 500 mgd would be required at that time. Cumulative impacts for expansion to 500 mgd will be measured at the year 2001.

3. All project components will be assumed to last as long as the project is operational, estimated here to be at least 75 years.

4. There would be no additional raw water supplies required for operation at the 125 mgd level before 1988. Additional raw water supplies must be available at that time in order to satisfy the projected treated-water demand associated with the population current water use trends and expected treatment plant capacity. It is assumed that additional raw water supplies will be developed as needed to meet demand.

5. In order to consider maximum impacts, the impact of providing additional raw water supplies will be considered at the maximum level of implementation, 500 mgd.

6. Obtaining additional raw water will, at some point, involve changes in the flows within sections of the South Platte River watershed. In Chapter 3, analysis of the impacts of obtaining more raw water will begin at the highest upstream point on the South Platte River and its affected tributaries. Chapter 8, Alternatives, will contain a general analysis of impacts related to the development and operation of various facilities required to increase the DWB raw water supplies.

7. The assumed population growth during the period of the project will be based on projections of the Denver Regional Council of Governments (DRCOG) as shown in Table 1-4.

Considerable evidence exists to support the hypothesis that low per capita availability of water does not inhibit in-migration to an area once a population has acquired a motivation to locate in the area. The motivation for in-migration may be social (religious, nationalistic, recreation, etc.) or economic (profits, and/or jobs, from oil, uranium, coal, etc.) or combinations of both types of motivation.

Professor Dietz of the University of California, Davis, in his study of Santa Barbara and San Luis Obispo Counties found that "While the provision of water supplies alone cannot cause growth in a region where it would not otherwise occur, the amount, timing, cost and management of water supplies can influence the location, rate, and type of growth in local areas." Dietz points out that other researchers have noted the same phenomenon (Rivkin/Carson 1971; Bascom, et al. 1975; Urban Systems Research and Engineering, 1976). In addition, opponents (Water Users Alliance) and proponents (DRCOG) of the proposed project have investigated the possible influence of the proposed project on in-migration of population into the Denver area. Both agree that the project will neither stimulate nor suppress population growth. They also agree that the project will have an influence on population settlement patterns within the area. This is discussed in the Future Without the Project and in the No Action alternative, i.e., the new population will flow mainly into Douglas County which has a large pure water aquifer.

Arid areas in the United States that have experienced substantial in-migration for social and/or economic reasons are Salt Lake City, Utah; Las Vegas, Nevada; Phoenix and Tucson, Arizona; and Palm Springs and Los Angeles, California. Abroad, North Africa has had significant in-migration due to economic and nationalistic-religious motivations in spite of low per capita availability of water.

The Division of Accounts and Control of the Colorado State Budget Office using the published population statistics of the U. S. Bureau of the Census calculated percent population changes in Denver County in the State of Colorado and found that between 1950 and 1960, which covers the period when the DWB "blue line" was in effect (1951-57), population increase was 18.2 percent. It does not appear that the implementation of the blue line which was a restriction on tap size and new taps within the DWB system stopped population growth. This is comparable to the 1970-80 period because both periods had or are having drought situations, both periods had or are having water tap restrictions, and both periods had or are having continued population growth.

Nearby arid areas that have experienced severe in-migration stimulated by energy development are Craig, Colorado, Rock Springs, Wyoming, and Gillete, Wyoming. None of these municipalities had adequate infrastructure at the time they received the population impacts; nevertheless, the in-migration continued. Without exception, boom areas stimulate in-migration and then grapple with the infrastructure problem ex post facto.

Despite profound differences between the boom town communities and Denver, with reference to community size, rates of growth and development, and sophistication of existing infrastructure, the experience of these communities indicates a general readiness to make trade-offs between the temporary inconvenience of inadequate infrastructure and economic growth. An outstanding recent major example of this is Saudi Arabia which is seriously considering expensive science fiction-type solutions to the water shortage problem such as towing icebergs from the Antarctic and desalinization of water from the Mediterranean Sea.

The stimuli to induce in-migration of population into Colorado exist today in the form of opportunities to obtain jobs and make profits from coal, oil, oil shale, uranium, CO_2, molybdenum, nahcolite and the outdoor recreation industry; furthermore, this is not a complete list. In the past the stimuli were gold, silver, and land. Removal of the aforementioned stimuli would be the most effective way of slowing, or stopping, in-migration of population into Colorado.

A poll conducted among household members in Denver, Adams, Arapahoe, and Jefferson Counties in the summer of 1977 found that only 4 percent of the non-native Coloradans inquired as to the adequacy of the future water supply before moving into the area. When asked why they moved to Colorado, a plurality, 38 percent, said that job opportunity was the reason. The second largest category, 17 percent, said they relocated because of the climate and weather (4-C Company 1977).

The constantly accelerating development of the various energy and energy-related resources throughout Colorado will cause in-migration not only to the development sites because of job opportunities, but due to the multiplier effect, these resources will create more than an equal number of service industry jobs, including those in corporation administrative headquarters. Many of these jobs, both service industry and administrative, will be located in Denver, a fact which is confirmed by observing the number of skyscrapers already built and being built in Denver's financial district. It is well known that corporation planners do not make heavy capital investments such as those in skyscrapers unless the probabilities are high that there are profits to be made and that there will be jobs for workers in the buildings. If past experience is a guide, no more than 4 percent of the new population will inquire about the adequacy of the future water supply before moving into the area, and the probabilities are high that even if they do make inquiries, job and profit opportunities will be the determining factor in relocation decisions.

8. Any impacts over 30 years will be considered permanent.

9. The following data concerning individual project elements have been abstracted from the detailed description of the proposal and are assumed to be accurate data for impact analysis:

Project Elements	125 mgd Development	500 mgd Development
DAM		
Height, above stream bed	243 feet	N/A
Crest Elevation	6,002 feet	N/A
Crest Length	601 feet	N/A
Thickness	31 feet at base 10 feet wide at crest	N/A
Excavation	130,000 cubic yards	N/A
INTAKE TOWERS		
Denver Intake	A hexogonal structure 35 feet thick at the base and 179 feet tall.	N/A
Aurora Intake	A square structure 21 feet thick at the base and 123 feet tall.	N/A
RESERVOIR		
Normal Capacity	7,700 acre-feet at 6,002 foot elevation.	N/A
Silt-storage Capacity	2,110 acre-feet (75 years)	N/A

Project Elements	125 mgd Development	500 mgd Development
Surface Area	98 acres at 6,002 foot elevation.	N/A
Pool Length	1.7 miles at 6,002 foot elevation.	N/A
TUNNEL		
Length	17,967 feet in 3 segments	N/A
	1,705 feet of 10.5-foot diameter concrete-lined tunnel from intake tower to Stevens Gulch. 170 feet of 10.5-foot diameter conduit in Stevens Gulch. 17,092 feet 10.5-foot diameter concrete-lined tunnel to the east portal.	N/A
Excavation	143,000 cubic yards 40% from Stevens Gulch 60% from East Portal	N/A
Aggregate Needs	53,000 cubic yards	N/A
TREATMENT PLANT COMPLEX		
Conduit 26 length	1,721 feet of buried 10.5-foot diameter pipe from east portal to the treatment plant.	N/A
Power generation (hydroturbine capacity)	11 million kilowatt-hours annually	28 million kwh annually
Aurora Intertie System	2 segments: 2,450 feet of 54-inch buried conduit 1,500 feet of 60-inch buried conduit	N/A
Treatment Capacity	125 mgd	375 mgd
Plant Structures	25 aboveground improvements	36 aboveground improvements
	9 underground structures	14 underground structures
	65 acres occupied by structures	49 acres occupied by structures
Sludge Production	Averages 4,490 pounds/day	Averages 28,500 pounds/day

Project Elements	125 mgd Development	500 mgd Development
Internal access	Asphalt surfaced road 3,700 feet long; Graveled road 2,600 feet long (temporary)	N/A
CONDUIT NO. 27		
Length	53,800 feet of 108-inch buried steel or concrete cylinder from treatment plant to Highland Reservoir	53,800 feet of 108-inch buried steel or concrete cylinder from treatment plant to Highland Reservoir.
	33,000 feet of 90-inch conduit from Highland Reservoir to Hillcrest Reservoir	33,000 feet of 90-inch conduit from Highland Reservoir to Hillcrest Reservoir.
Rights-of-Way	60,800 feet at 100 feet wide or 140 acres.	Same R/W as 125 mgd
	10,000 feet at 80 feet wide or 19 acres.	Same R/W as 125 mgd
	16,000 feet; street R/W	Same street R/W as 125 mgd
Access	Temporary road paralleling conduit	Temporary road paralleling conduit
ACCESS ROADS AND STAGING AREAS		
Road Improvements	20,400 feet of 22' wide gravel surface.	N/A
	6,400 feet of 13' wide graded surface with turnouts.	N/A
POWERLINES AND TELEPHONES		
Dam and Stevens Gulch portal	13.2 kilovolt overhead lines, 2.8 miles with telephone lines on same poles.	N/A
Treatment Plant and East portal	12.6 kilovolt overhead line, 2,500 feet with telephone lines on same poles.	N/A

Project Elements	125 mgd Development	500 mgd Development
MANPOWER DATA		
Construction	Average of 317 persons per year working 3 8-hour shifts 7 days a week for 3 years.	Average of 160 persons per year work 3 8-hour shifts 7 7 days a week for 6 years.
Operation and Maintenance	25 workers for the life of the project - 75 years.	10 additional workers for the life of the project - 75 years.

SOCIO-ECONOMIC CONDITIONS

Human Populations

As proposed, the Foothills Project would not alter future population trends in the Denver metropolitan area (assumption 7 at the beginning of this chapter). There appear to be economic, social, scenic, recreational, and climatic aspects of the Denver area that have caused continuous in-migration at a rate greater than the national average since World War II (Bureau of the Census 1970).

Employment and Manpower

The number of unemployed construction workers in the DBLMA in March 1977 was 3,753 (Table 2-1). Since a maximum of 460 workers would be employed during the construction of the first 125 mgd capacity of the project (Figure 1-2) and assuming that the number of unemployed construction workers would not change, the peak impact of constructing the first 125 mgd capacity of the project would be to reduce unemployment among construction workers by 12.3 percent.

An average of 317 workers would be employed annually over the three-year construction period of the 125 mgd facility. Again, assuming stability among the number of unemployed construction workers, the impact would be to reduce unemployment among the workers an average of 8.5 percent over the three-year period.

An additional work force averaging 160 workers per construction year for six years would be required to expand the project to the 500 mgd level. If the number of unemployed among construction workers remains stable at 3,753, the impact of this construction would be to reduce unemployment among these workers by 4.3 percent over the six-year construction period.

An estimated 25 people would be employed for operation and maintenance of the 125 mgd facility and an additional 10 people would be required for operation and maintenance at the 500 mgd level, making a total work force of 35 maintenance workers for the duration of the project. Assuming continued stability among the number of unemployed transportation and public utilities workers, which was 649 during March 1977 (Table 2-1), the project would reduce unemployment among these workers by 5.4 percent.

Accidents

Construction of the Foothills Project would probably result in work-related accidents involving vehicles and workers. Table 3-1 summarizes the accidents causing lost time anticipated during construction and operation of the project. During the three years of construction, an estimated 43 accidents would occur, each resulting in injury with loss of at least one work day. Construction of additional increments to implement the 500 mgd capacity would result in an estimated 88 additional accidents. During the 75-year life of the operating facility, there would be an estimated 20 accidents involving motor vehicles supplying the treatment plant with supplies and chemicals. Transport trucks hauling chlorine would probably be involved in about 7 accidents and ammonia transports would probably be involved in about 3 accidents (Table 3-1). Although statistics are not available to predict the frequency of serious vehicular collisions or major accidents that might result in a toxic chemical spill, the DWB indicates it has never experienced such an accident. In general, accidents would be expected to occur at the rate of one every 11 years for chlorine transports and one every 22 years for ammonia transports. Because of the way the transports are designed, it is improbable that a rupture and chemical spill would occur.

Income

The estimated cost of constructing the first 125 mgd increment of the project would be about $134,000,000, which would be expended over a three-year period; this would amount to an average of about $44,667,000 annually. The estimated total gross 1975 domestic product in the Denver area is $7,277,400,000 (DRCOG 1974c). Therefore, if the entire expenditure for the project were local, it would have the direct effect of adding 0.6 percent to the gross domestic product annually. There would also be small undetermined multiplier effects.

However, over the three-year construction period, there would be significant human impacts on approximately 317 families and/or individuals (the average number per month which would be hired during the construction period--Table 1-2) who would receive average annual gross incomes of about $16,000. Some local subcontractors would also receive significant income. The DWB concluded that it would be impossible to calculate subcontractor income at this time.

Expansion to the 500 mgd level will result in additional spending of $131,084,000 (this is an escalated figure equal to $54,680,000 in 1978 dollars) by 2001, resulting in an additional economic impact smaller than that of the first increment. There would be, however, significant positive impacts on the average of 160 worker families and/or individuals who would earn annual incomes not less than $16,000

TABLE 3-1

ANTICIPATED LOST TIME ACCIDENTS
DURING CONSTRUCTION AND OPERATION OF THE FOOTHILLS PROJECT

Type of Work	1974 Accident Rate in Incidents per 1,000,000 Hours Worked 1/	Probable Number of Accidents Related to Construction of Phase I of the Foothills Project (125 mgd)	Probable Number of Accidents Related to Construction of Phases II, III and IV of the Foothills Project (500 mgd)	Total Number of Accidents	Probable Accidents during 75 years of Operation
General construction (approximately 300 workers annually)	13.50	21	35	56	Not applicable
Underground mining (approximately 50 workers annually)	25.26	6	Not applicable	6	Not applicable
Motorized transport (trucks)	9.36 2/	16	53	69	20 3/

1/ National Safety Council 1974.

2/ Units in incidents per one million miles.

3/ Breakdown of accidents related to transport trucks includes the following: (1) Chlorine transports - 7 accidents; (2) Ammonia transports - 3 accidents; (3) Other supply transports - 10 accidents. Based on an average distance of 40 miles per delivery according to delivery frequency cited in Table 1-9.

over the six-year construction period involved in expanding to the 500 mgd level (Figure 1-4).

The average number of workers hired per month for the 112 months involved in constructing the entire 500 mgd capacity project would be 216. These workers would earn incomes not less than $16,000 annually. The number of jobs generated in the Denver area's services industry would at least equal the number hired for the proposed project.

The total cost of the 500 mgd project would be $265,084,000, an average of $26,508,400 annually for a ten-year period. This would have a very small impact on Denver's $7 billion plus economy, about 0.36 percent annually.

The impact of operation and maintenance on gross income earned in the Denver area would be slight since it would involve only 25 to 35 new jobs for workers, all at the treatment plant. However, the impact on families of these workers would be significant; they would be assured a steady income, which traditionally has been a key variable in a stable family life.

Lifestyles

The principal impact on community lifestyles of building the first 125 mgd treatment capacity of the project would be to permit the population in the DWB service area to maintain lifestyles related to present water consumption until about 1988. The impact of expanding the facility to the 500 mgd level would be to allow people in the DWB service area to maintain these lifestyles until 2001.

Utilities

Municipal and Industrial Water Systems

The construction of the Foothills Project at a capacity of 500 mgd would enable the DWB to meet projected maximum-day requirements through the year 2001 (Table 1-4). Availability of the Foothills' 125 mgd treatment capacity in addition to present facilities would essentially eliminate maximum-day shortages during the peak-use periods through 1988. By 1988, additional treatment capacity would be required because maximum-day demands would continue to increase with population. In addition, with the availability of additional reliable raw water supplies, restrictions on use would not be necessary within the DWB service area.

Table 3-2 displays the projected use of water within the DWB service area compared to the supply available with the treatment capacity increased by 125 mgd (to 645 mgd) and with no increase beyond present raw water supplies. Beginning in 1988, additional treatment capacity and more raw water would be required to provide treated water for the projected population at levels consistent with current use trends.

Figure 3-1 displays the monthly use of treated water expected in 1988 with the project at 125 mgd. The shortage shown indicates that additional treatment capacity and raw water is required. Figure 3-2 shows the monthly use of treated water expected if the 500 mgd Foothills plant is implemented.

Construction of additional 125 mgd increments of the treatment plant would involve development of additional reliable raw water supplies to satisfy projected maximum-day demand. The full proposed treatment capacity of 500 mgd would be needed by the year 2001 (Table 1-4) to satisfy maximum-day needs.

Wastewater Treatment Facilities

The Foothills Project should not have a significant impact on wastewater treatment facilities. This statement is based upon the discussion of wastewater treatment facilities in Chapter 2 and in Table 2-5 which indicates that facility capacities will keep pace with population growth.

There is normally a slight summertime peak in wastewater flows. People take more showers, wash clothes more often, drink more fluids, and in other ways use more water in summer months. There would be no detrimental effects, however, on wastewater facilities if capacity keeps pace with demand per Table 2-5.

Water used for lawn irrigation and other runoff from precipitation does not flow directly into wastewater treatment plants. A certain amount of irrigation and other runoff water does infiltrate into sewerlines through joints, particularly in older lines. The amount has not been precisely measured, but it is dependent upon the water table level. If the water table is high or above the pipe elevation, there is more infiltration than if, for example, there were a drought and water tables were low. Water then settles lower than the sewerlines.

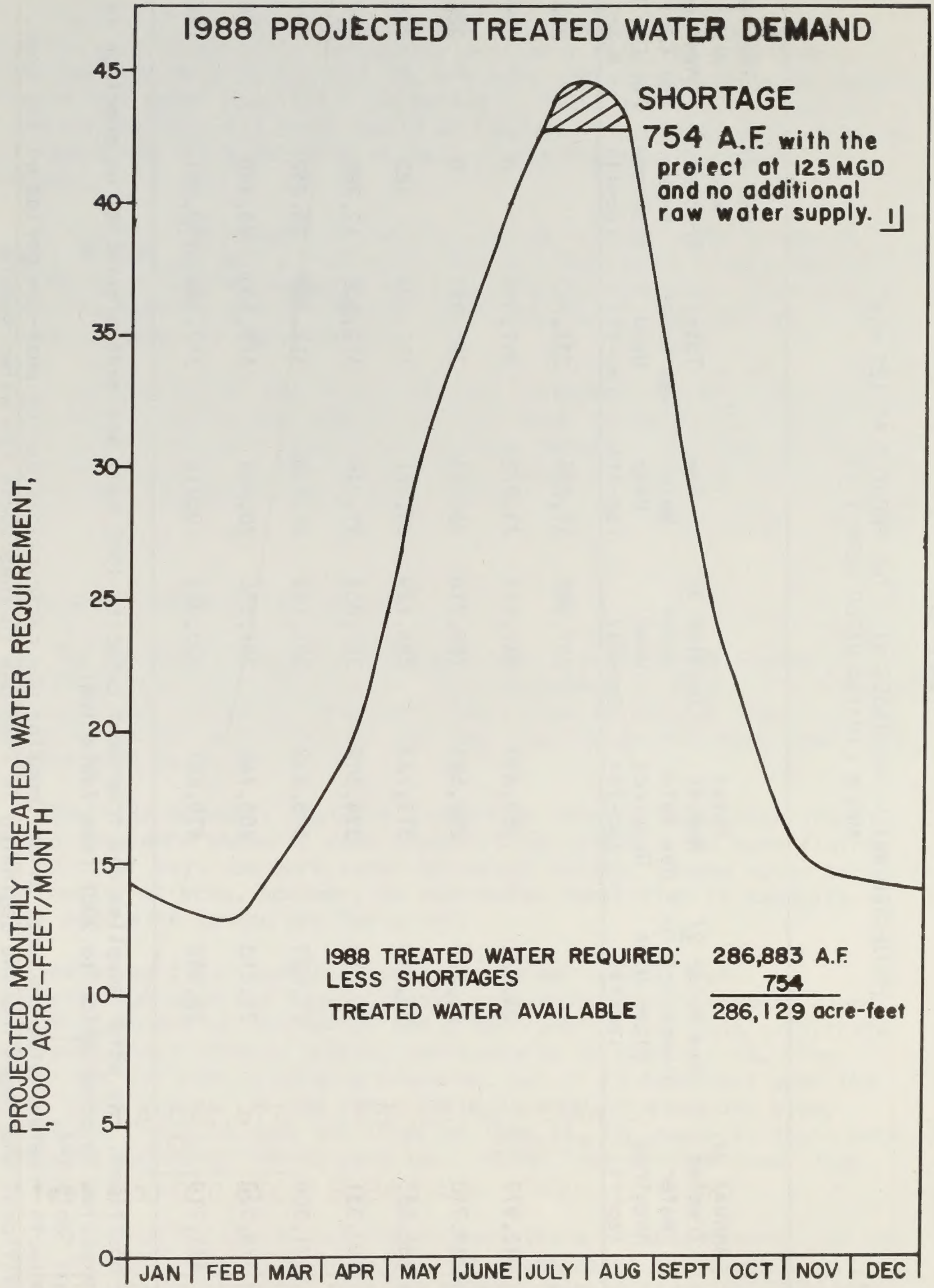
Infiltration should decline in the future because federal law now requires that sewerlines be maintained or replaced to reduce or prevent excessive infiltration and thereby reduce flows to wastewater facilities instead of adding treatment capacity because of

TABLE 3-2

PROJECTED WATER SHORTAGES WITH THE PROJECT AT 125 mgd
AND A LIMITED WATER SUPPLY 1/

Year	Annual 2/ Treated Water Required (ac-ft)	Raw Water 2/ Diversions to Other Uses (ac-ft)	Total Annual Raw Water Required (ac-ft)	Treated 3/ Water Used (ac-ft)	Raw Water Used (ac-ft)	Total Raw Water Used (ac-ft)	Raw 4/ and Treated Water Shortage (ac-ft)	Treated Water Average Per Capita Per Day Use (gdc)
1975				207,982	27,883	235,865		208
1980	242,977	24,922	267,899	242,977	24,922	267,899	0	226
1985	269,710	26,243	295,593	269,710	26,243	295,953	0	228
1988	286,883	26,240	313,123	286,129	26,171	312,300	823	228
1990	298,331	26,238	324,569	287,054	25,246	312,300	12,269	220
2000	371,509	27,023	398,532	291,124	21,176	312,300	86,232	181
2001	378,530	27,210	405,740	291,356	20,944	312,300	93,440	178
2010	441,719	28,962	470,681	293,084	19,216	312,300	158,381	154

1/ If additional raw water supplies and treatment capacity (500 mgd) are made available, no shortage is expected to occur prior to 2001 (see Table 1-4).
2/ From Table 1-4.
3/ Reflects treated water consumed after imposing use restrictions during peak-use period of the year.
4/ Additional shortages imposed beginning in 1988 due to inadequate raw water supply.



1 Shortages predicted upon inability to satisfy treated water demand.

FIGURE 3-1

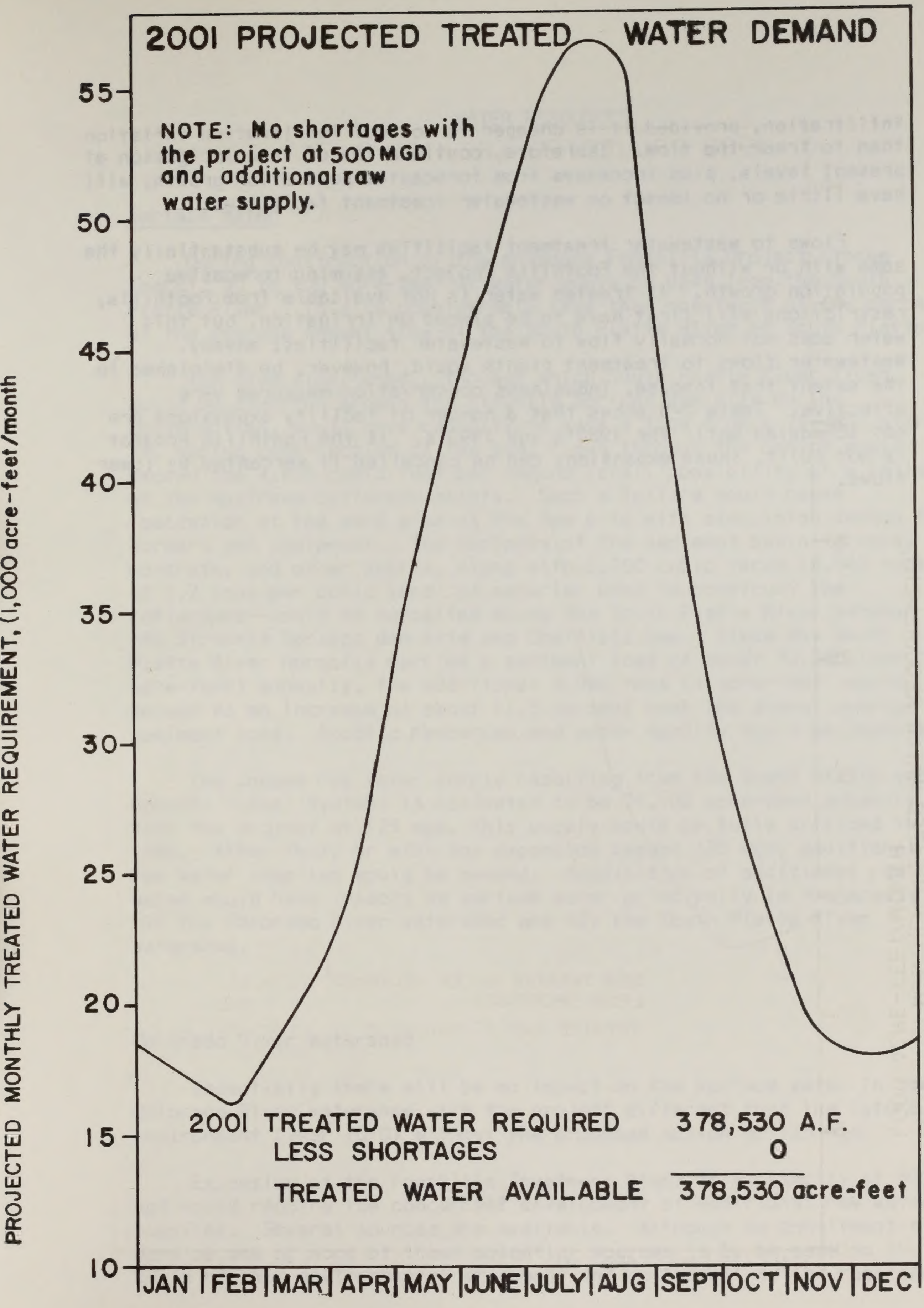

2001 PROJECTED TREATED WATER DEMAND
NOTE: No shortages with the project at 500 MGD and additional raw water supply.
PROJECTED MONTHLY TREATED WATER REQUIREMENT, (1,000 acre-feet/month
55
50
45
40
35
30
25
20
15
10
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
2001 TREATED WATER REQUIRED 378,530 A.F.
LESS SHORTAGES 0
TREATED WATER AVAILABLE 378,530 acre-feet

FIGURE 3-2

infiltration, provided it is cheaper to control infiltration inflation than to treat the flow. Therefore, continuation of lawn irrigation at present levels, plus increases from forecasted population growth, will have little or no impact on wastewater treatment facilities.

Flows to wastewater treatment facilities may be substantially the same with or without the Foothills Project, assuming forecasted population growth. If treated water is not available from Foothills, restrictions will first have to be placed on irrigation, but this water does not normally flow to wastewater facilities, anyway. Wastewater flows to treatment plants would, however, be diminished to the extent that inhouse, inbusiness conservation measures were effective. Table 2-5 shows that a number of facility expansions are not scheduled until the 1980's and 1990's. If the Foothills Project is not built, these expansions can be cancelled if warranted by lower flows.

Surface Water

During construction of the proposed Foothills Project (three years), 90 to 100 acre-feet of water would be used from the South Platte River. This is considerably less than one-tenth of one percent of the average annual flow of the South Platte River at South Platte.

The diversion tunnel, through which South Platte River flows would be diverted around the Strontia Springs dam site during construction, would have capacity to pass a flow from a 25-year storm. If, during construction of the dam, flows through the canyon would exceed the 4,400 cubic feet per second (cfs), possibility of a failure of the upstream cofferdam exists. Such a failure would cause inundation of the work area at the dam site with associated damage to workers and equipment. The contents of the sediment basin--grease, concrete, and other debris, along with 6,700 cubic yards (8,040 tons at 1.2 tons per cubic yard) of material used to construct the cofferdams--would be deposited along the South Platte River between the Strontia Springs dam site and Chatfield Dam. Since the South Platte River normally carries a sediment load of about 70,000 tons (36 acre-feet) annually, the additional 8,040 tons (4 acre-feet) would amount to an increase of about 11.5 percent over the annual average sediment load. Aquatic resources and water quality would be impacted.

The unused raw water supply resulting from the South Platte and Roberts Tunnel Systems is estimated to be 79,100 acre-feet annually. With the project at 125 mgd, this supply would be fully utilized in 1988. After that, or with any expansion beyond 125 mgd, additional raw water supplies would be needed. Acquisition of additional raw water would have impacts on surface water principally in two areas: (1) the Colorado River watershed and (2) the South Platte River watershed.

Colorado River Watershed

Essentially there will be no impact on the surface water in the Colorado River watershed with the project different than the future environment (year 2010) without the proposed action at 125 mgd.

Expansion of the Foothills Treatment Plant to a capacity of 500 mgd would require the concurrent development of additional raw water supplies. Several sources are available. Although no commitment to develop one or more of these potential sources is to be made on the basis of this environmental statement and no federal action regarding

the development of these potential sources is proposed, discussion of several of these sources and their general impacts are presented in Chapter 8 for general informational purposes. All of these sources are tributaries of the Colorado River: Fraser, Williams Fork, Blue, and Eagle Rivers.

South Platte River System

Operation of the proposed Strontia Springs Dam and Foothills plant at a capacity of 125 mgd could increase flows on the North Fork of the South Platte River from the present 400 cfs up to about 595 cfs. Increased flows would normally occur during the peak water-use period of the year, generally July and August. Sometimes, though rarely, all of the 595 cfs might be released from the Roberts Tunnel, when there would be a complete lack of South Platte River water available for direct diversion under DWB's water rights and a concurrent lack of water stored in DWB's South Platte River reservoirs or physical constraints impeding the use of that stored water. Average annual flows on the North Fork of the South Platte would increase until about 1988, when the amount of reliable raw water supply presently available to the system would be fully utilized. Projected average annual flows at a number of locations in the South Platte River watershed are shown on Table 3-3.

Table 3-4 presents average monthly discharge at several locations within the South Platte River watershed with the additional Roberts Tunnel water and the Foothills plant in operation at a capacity of 125 mgd. These flows are based on the assumptions listed below.

1. Operation of Foothills Project and full utilization of the reliable water supply of South Platte and Roberts Tunnel system is superimposed upon the average streamflow and diversions as reflected by the 10-year period, 1964-1973.

2. Average monthly streamflow of the South Platte River at Waterton is representative of the flow anticipated to occur after the initial unit of the Foothills Plant becomes operational in the event of the recurrence of a similar 10-year period. Exchange of transmountain sewage effluent and acquisition of additional water rights would reduce the flows at Waterton.

3. Historical diversions in the reach of the South Platte River between South Platte and Waterton for other than DWB treated water purposes would remain the same (31,900 acre-feet).

4. Moffat Treatment plant would operate for a 6-month period, April through September.

TABLE 3-3

PROJECTED AVERAGE ANNUAL FLOW AT KEY GAGING STATIONS
WITH THE FOOTHILLS PROJECT AT 125 MGD.

Gaging Station	Projected Discharge 1988 cfs	ac-ft
South Platte River below Cheesman Dam	117	128,200
Roberts Tunnel Imports	156	112,900
North Fork South Platte below Grant with Roberts Tunnel	224	162,300
North Fork South Platte at South Platte with Roberts Tunnel 1/	307	222,600
South Platte River at South Platte with Roberts Tunnel 1/	521	377,100
South Platte River below Denver 2/	711	514,600

1/ Flows reflect assessed losses of 5 percent on Roberts Tunnel diversions.

2/ Includes the sum of South Platte River at 19th St. gage plus estimated sewage return (57 percent of additional Roberts Tunnel import) and gaged discharge of Clear Creek at mouth.

TABLE 3-4

PROJECTED MONTHLY AVERAGE DISCHARGES (in cfs) IN THE NORTH FORK SOUTH PLATTE RIVER AND THE SOUTH PLATTE RIVER AT 125 mgd IN 1988 1/

Month	Future Roberts Tunnel Imports 2/	North Fork South Platte at Grant	North Fork South Platte at South Platte	South Platte River at South Platte
January	142	159	181	248
February	136	151	172	237
March	135	153	178	258
April	175	201	258	463
May	169	291	511	1,063
June	156	297	531	951
July	131	287	416	816
August	240	325	442	758
September	199	246	309	504
October	193	231	280	395
November	148	177	216	307
December	143	165	185	255
Annual Average Flow (in cfs)	156	224	307	521
Annual Average Flow (in acre-feet)	112,900	162,300	222,600	377,100

1/ The future imports have been reduced by 5 percent loss at South Platte stations.

2/ Based on population projections and historical use patterns, the 112,900 acre-feet raw water available in Dillon Reservoir would be in use by 1988.

5. The values of discharge so derived are not absolute due to the vagaries of climatic, hydrologic, and demand conditions from year to year. Absolute prediction of the pattern of operation of the DWB treatment facilities cannot be determined.

Due to the elevation of the Foothills Treatment Plant site, the proposed facility would be operated year-round as a baseload plant rather than limited to the peak-use period of the year. In 1988, if the plant were operating at a capacity of 125 mgd continuously year-round, the flows diverted at Strontia Springs would be 193 cfs (125 mgd).

Average annual flows in the reach of the South Platte River between Strontia Springs dam site and the Platte Canyon Intake Diversion Dam have averaged about 298,000 acre-feet per year (1964-73), or 412 cfs. With the project operating at 125 mgd and full utilization of South Platte River and Roberts Tunnel system reliable raw water supplies in 1988, the annual flows at Strontia Springs Reservoir would average 377,100 acre-feet or 521 cfs. Flows downstream of the Strontia Springs Dam after diversion of 193 cfs (125 mgd), assuming year-round operation of the Foothills Plant, would average 328 cfs.

Average monthly flows of the South Platte River below Strontia Springs Dam and the Platte Canyon Intake Diversion Dam were derived using the previously discussed assumptions as shown on Table 3-5.

Projected average monthly discharge on the North Fork of the South Platte River at Grant with the Foothills plant operating at a capacity of 125 mgd are within the sustainable level of 680 cfs incorporated in the channel stabilization work completed to date.

Description of the environmental impacts associated with the operation of a Foothills plant with a capacity of 500 mgd are very difficult to assess at this time. As was discussed in Chapter 1 under Proposed Action, the operation at capacity 500 mgd of the Foothills Treatment Plant would create a maximum instantaneous demand for raw water of up to 775 cfs on the South Platte River at the Strontia Springs Diversion Dam. This is 580 cfs more than the maximum flow required at 125 mgd and would result in the flows of greater velocity and increased depth.

If the Marston and Kassler Treatment Plant Intakes would also use water at capacity, there would be a maximum instantaneous total demand for raw water from the South Platte River of 1,175 cfs. This would generally occur during the peak-use period of the year. Availability of water to meet such a requirement would depend on the locations of facilities providing additional water.

TABLE 3-5

PROJECTED MONTHLY AVERAGE DISCHARGES OF THE SOUTH PLATTE RIVER WITH PROJECT AT 125 mgd, 1988 (in cfs)

Month	South Platte River at South Platte 1/	South Platte River below Strontia Springs	South Platte River at Waterton
January	248	55	27
February	237	44	19
March	258	65	18
April	463	270	145
May	1,036	843	643
June	951	758	550
July	816	623	403
August	758	565	325
September	504	311	134
October	395	202	86
November	307	114	65
December	255	62	31
Annual Average Flow (in cfs)	521	328	205
Annual Average Flow (in acre-feet)	377,100	237,500	148,400

1/ Flows reflect assessed losses of 5 percent on Roberts Tunnel diversions.

Several facilities which can provide raw water for treatment at the proposed Foothills plant site are described in Chapter 8. The facilities include Chatfield Dam and Reservoir, Two Forks Dam and Reservoir, and additional collection facilities in the Blue and Eagle River watersheds. Exchange of transmountain sewage effluent with senior water users on the South Platte River downstream of Denver and the acquisition of water rights would also permit the diversion of additional water from the South Platte River for treatment.

Implementation of any one or combination of these would impose somewhat different flow patterns on the Eagle and Blue River watersheds. These patterns would vary with the location of the new facilities and the amount of water diverted. The same is true in the South Platte River watershed.

Flows downstream of the DWB diversion facilities in the Waterton Canyon would be reduced through transmountain sewage effluent exchange and water rights, the amount depending on exchange criteria and the water rights acquired.

These annual flows in the North Fork of the South Platte River would increase over those for operation of the Foothills plant at 125 mgd with any of these facilities, the amounts of flows and discharge patterns varying with which facilities are developed. Further discussion of the gross impacts associated with the potential additional raw water facilities is presented in Chapter 8.

Water Quality

Impacts on the surface water quality in the Colorado River watershed with the project at 125 mgd would be the same with or without the proposed action. Therefore, such impacts are described in Chapter 8 under the No Action alternative.

Presentation of the water quality impacts in the Colorado River watershed associated with the 500 mgd treatment plant is made in Chapter 8 as a part of the discussion of the raw water concepts. Increased diversions from the Colorado River watershed would remove salts from the basin and increase salinity concentrations downstream.

At the present time, it is estimated that the transmountain diversions from the Colorado River to the Denver Metropolitan Area (including Roberts Tunnel, Moffat Tunnel, Homestake, Colorado-Big Thompson, Ranch Creek, and several small diversions) account for a salinity increase of approximately 1.2 percent in the Colorado River Basin measured below Imperial Dam. If all existing transmountain diversion rights for the Denver area were fully utilized, the estimated salinity increase due to Denver diversions would be about

1.6 percent. Thus, more than 98 percent of the salinity problem in the Colorado River is attributable to irrigation return flows, municipal and industrial point sources and natural salinity sources located in the Colorado River Basin.

During construction, the water quality of the South Platte River, 1.7 miles upstream and 2.6 miles downstream of the construction area, would be affected by the addition of sediment from distrubed areas. Sediment would be caused by reservoir construction, and powerline and telephone line construction.

During the three years required for reservoir construction, about 75 tons (0.04 acre-feet) of additional sediment would be carried into the South Platte River annually from this source. Seventy tons of sediment would be generated during the first year from disturbed areas created during road construction and another 12.5 tons would be generated during the first year from areas disturbed by powerline and telephone line construction. Most of these sediments would be added to the South Platte during the predicted 11 storms when precipitation exceeds 0.5 inches. During the first year of the three-year construction period, about 157.5 tons (0.08 acre-feet) of sediments would be added to the South Platte River, which is currently carrying a full bedload of 70,000 tons (36 acre-feet) of sediments annually past a given point. The additional 157.5 tons of silt would probably drop to the bottom downstream as the river regains a balanced condition. Eventually, the additional sediments would reach the South Platte Intake. There would be no impacts on water quality below this point. How the additional sediment would affect turbidity cannot be predicted. There is no known method to correlate additional amounts of particulate matter to increased turbidity (measured in JTUs) since it is dependent on reflective characteristics of the particles, such as shape and size.

After construction is completed, and the facilities are operating, the quality of the water impounded in Strontia Springs Reservoir will be dependent on the quality of inflows. With the high water exchange rate anticipated for the reservoir, there probably would be little time for the geologic or climatic forces within the canyon area to affect the water quality to any great extent. Table 3-6 shows the estimated water quality values for the impounded water, based on the characteristics of inflowing waters. Water released from the reservoir would probably be of a quality similar to that impounded except that sediment load would be less. This sediment bedload would be reduced by 78 percent of capacity, from 70,000 to 15,600 tons annually (Geology, Topography, and Minerals section of this chapter).

The net effect of the lowered sediment load on water quality would be to reduce the turbidity in the 2.6 miles of the South Platte River between the Strontia Springs Dam and the South Platte Intake.

TABLE 3-6

PREDICTED AVERAGE QUALITY OF WATER
IN THE STRONTIA SPRINGS RESERVOIR

Variable	Maximum 1/	Average Range 1/	Minimum 1/
Water temperature (°F.)	72.00	43.00- 48.00	32.00
Turbidity (JTU) 2/	70.00	1.10- 8.00	0.10
Color units	100.00	11.00- 48.00	5.00
Conductivity (micromhos) cmd	455.00	166.00-315.00	100.00
pH (SU) 3/	8.00	7.50- 7.80	7.10
Total alkalinity	112.00	56.00- 84.80	30.00
Total solids	285.00	120.00-183.50	26.00
Nitrate	0.55	0.07- 0.16	--
Phosphate	0.30	0.06	--
Total hardness	162.00	74.00-118.00	55.00
Calcium	40.00	21.30- 29.80	16.00
Magnesium	16.00	5.00- 10.00	2.30
Sodium	34.60	4.50- 26.00	2.70
Chloride	51.00	5.50- 30.00	0.20
Sulfate	75.60	32.00- 43.60	15.00
Fluoride	1.41	0.52- 1.10	0.35
Iron	0.84	0.09- 0.35	--
Manganese	0.29	0.05- 0.07	--
Coliform (100 ml)	6,000.00	0.00-240.00	--

Source: DWB 1974.

1/ Units are expressed in milligrams per liter except as where noted otherwise.

2/ Jackson Turbidity units.

3/ Standard units.

The net effects of sedimentation from disturbed areas would be insignificant since the river would be picking up sediments to regain its lost bedload. It is probable that the estimated 49.5 tons (0.03 acre-feet) of sediment added from disturbed areas during the first year of reservoir operation would be picked up by the river and quickly deposited in the South Platte Intake. There would be increased turbidity (not measurable), but it would probably not result in adverse impacts since the river would still be carrying sediments far below capacity.

Water quality in the South Platte River through Denver may be beneficially affected by the reduced sediment load. As previously discussed in this chapter, with respect to wastewater treatment facilities, the impact of the Foothills Project at either the 125 mgd or 500 mgd on South Platte River water quality would be negligible. That is primarily because runoff from irrigation and precipitation already contributes to a major instream pollution problem. If it is possible to solve the runoff pollution problem as it now exists, the added pollution increment from the Foothills Project can be handled concurrently. In other words, the runoff problem exists and will persist or be resolved regardless of whether or not Foothills is built.

Ground Water

Geologic formations that would be penetrated by the Foothills Tunnel are not known aquifers; however, it is possible that unknown weak aquifers in the sedimentary rocks near the east portal and in fracture zones in the metamorphic rocks could contain ground water. Excavation of the tunnel through formations containing ground water would result in leakage into the unlined tunnel and drainage to the lower end of the tunnel.

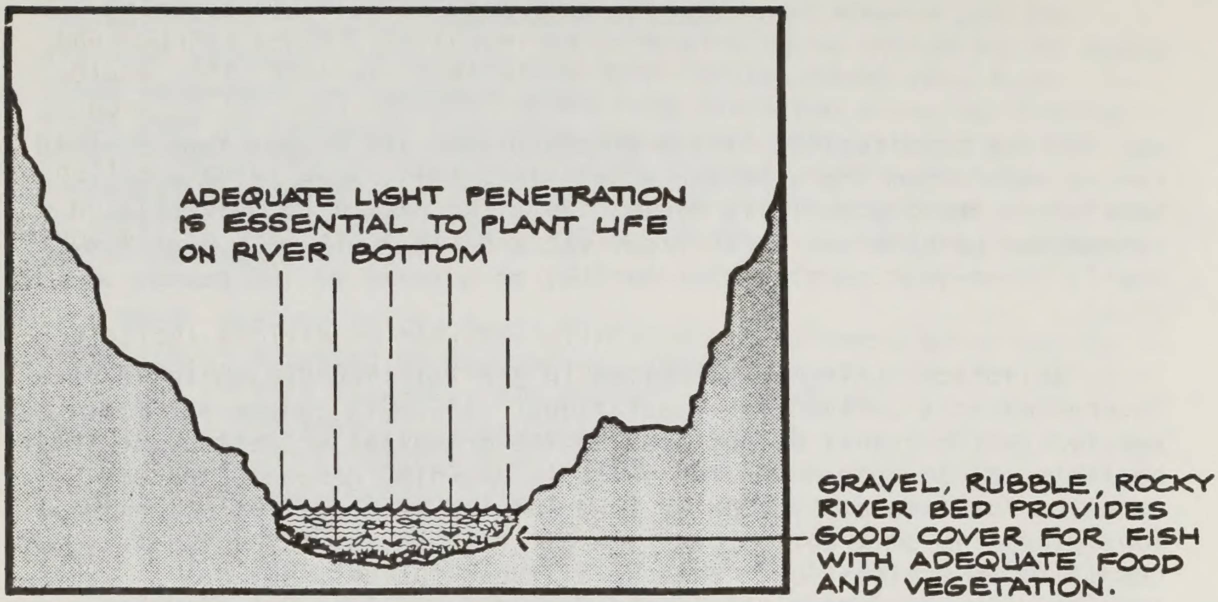
An undetermined amount of water would be lost from the ground water source between the time the tunnel was excavated and the time it was lined with concrete (1 to 12 months for the main tunnel and 1 to 5 months for the tunnel from the reservoir to Stevens Gulch). The water would flow to the lower end of either tunnel into sediment basins or treatment reservoirs where sediments would settle out.

AQUATIC RESOURCES

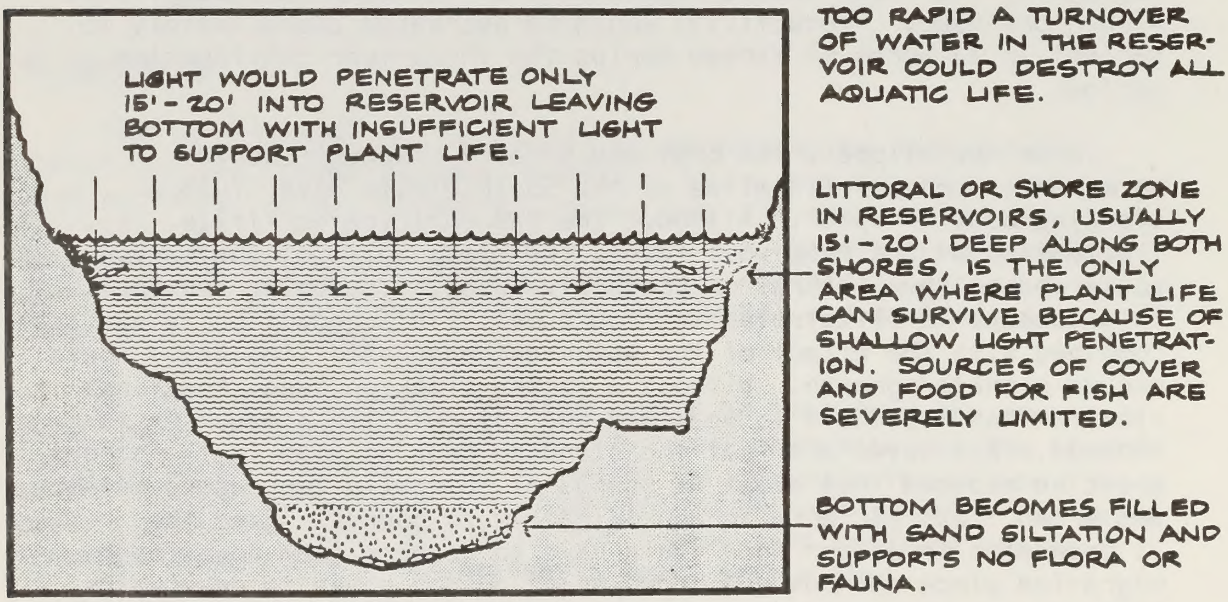
During construction of the proposed dam, the bypass tunnel would remove water from the site and eliminate about 1 acre of aquatic habitat in the South Platte River. About 64 pounds of naturally reproduced rainbow and brown trout would be lost annually over the nearly three-year construction period, or a total of 192 pounds of trout.

Siltation during construction in the Waterton Canyon would have several effects on the fish populations. It would reduce the food supply (bottom fauna) by suffocating the organisms or destroying their habitat. Silt would cover the suitable spawning grounds, thereby reducing the fish population by lowering its reproductive potential. More directly, silt would cover the gill filaments of the fish, resulting in suffocation. Because of these factors, natural productivity of aquatic life would be reduced in the 2.6 miles of stream from the dam site to the existing Platte Canyon Intake by about 10 to 20 percent (average 15 percent) during the three-year construction period. Once the dam began to operate and hold back sediments, the river should regain most of its aquatic productivity within one year. Productivity would be decreased approximately 15 percent in 34 acres of stream during the three-year construction period.

When operational, the proposed 95-acre reservoir would permanently convert 1.7 miles of the South Platte River into a standing body of water. Although the DWB anticipates little fluctuation of the reservoir level, the steep walls of the canyon would reduce the littoral or productive zone by reducing sunlight. This concept is illustrated in Figure 3-3. This reduction in sunlight combined with the effect of the water-exchange rate (ten days) would reduce plankton growth. Without a strong plankton base, the first link in the food chain is weakened and natural fish production is reduced. Estimates are that the standing crop of fish in the stream would be reduced from about 64 pounds of naturally reproduced rainbow and brown trout per acre to approximately 21 pounds. Even the 21 pounds of trout per acre would have to develop from downstream migration since rainbow and brown trout do not spawn in reservoirs. Although per-acre production would be reduced, an increase from about 14 acres of stream with 3.4 miles of shoreline to 95 acres of reservoir with 4.9 miles of shoreline would result in an increase in total fish biomass from 896 pounds to 1,995 pounds. This increase in biomass would probably be mainly nongame fish such as suckers. Therefore, the increased biomass would be of little or no value to fishermen.



Existing River – Productive Conditions



Typical Reservoir – Unproductive

CROSS SECTIONS
South Platte River Canyon

Source: DWB, 1974

FIGURE 3-3

Nothing, however, would offset the loss of suitable spawning areas in the 1.7 miles of stream to be inundated. Since rainbow and brown trout would not be able to spawn in the reservoir, they would move upstream in both spring and fall for that purpose. Increased numbers and catches of larger rainbow trout would be probable in the spring and larger brown trout in the fall, when sexually mature fish move upstream to such spawning grounds. This would improve fishing success on both the South Platte River and the North Fork of the South Platte River during those times of the year.

Studies by Erman (1973) of similar habitat conditions indicate that the nongame fish population would greatly increase upstream of the reservoir and upstream into the North and South Forks. The smaller year classes would dominate sucker populations in the stream and larger year classes would dominate the reservoir. Although the sucker population would benefit from the increased competition for food, the trout population would probably suffer. Data are not available to predict the actual effect on the trout population. Any reduction in trout populations would affect recreational values.

The dam and reservoir would destroy one amphibian pond; however, it is possible that others would be created in the Bear Creek or Willow Creek arms of the reservoir.

GEOLOGY, MINERALS, AND TOPOGRAPHY

Excavation of the dam foundation and abutments would change the existing topography. The excavation would be filled with the concrete of the dam's foundation, replacing the existing natural topography with a 243-foot high concrete dam.

As the reservoir is filled, geologic, mineral, and topographic features upstream of the dam and below the high water line (6,010 feet of elevation) would be periodically inundated and lost from view. The geologic features affected are very similar to those found in a large part of the Platte Canyon, and the loss is not thought to be significant. Existing data, based largely on geologic inference, indicate that the chances of discovering a minable ore deposit in the South Platte Canyon is very small. The chances of having a minable deposit in the 95 acres to be occupied by the dam and reservoir would, therefore, be even smaller. The construction and operation of the dam and appurtenant structures would, however, prevent prospecting during the life of the dam.

Shoreline erosion and landslides are possible effects of the fluctuating water levels.

The establishment of the treatment plant would not jeopardize any significant clay or limestone resources as the value of these deposits is very slight based on current economics and markets.

The seismic activity of an area has sometimes been known to increase with impoundment of large bodies of water, as a result of the increased pore pressure at depth. This pressure can cause previously inactive areas to become seismically active. This type of seismic activity is usually associated with reservoirs whose dams are over 300 feet high, but it has occurred with dams as low as 120 feet high. It is not known whether increased seismicity would result from filling the Strontia Springs Reservoir.

The river carries annually about 70,000 tons (36 acre-feet) of sediment past any given point. Based on the DWB-predicted sedimentation efficiency, 78 percent of these sediments, or 54,400 tons (21 acre-feet) per year, would probably be deposited in the relatively quiet waters of the reservoir. The sediment would be deposited below or at the water line in the upstream end of the reservoir. Some minor bars might develop, but none would protrude above the high water line. The waters that leave the reservoir would carry only 22 percent of their former load.

If total bedload were not regained before the river reached the existing downstream South Platte Intake, sedimentation within that

diversion structure would be reduced, requiring less maintenance of the facility.

The removal of less than 6,700 cubic yards of impervious fill for use in the cofferdams from an existing 1-acre pit near Kassler should cause that borrow area to be deepened an estimated 3 feet. This should not affect the human environment to a measurable degree.

The aggregate to be used in construction of the dam would be excavated from a site within the high water line of the newly completed Chatfield Dam on the South Platte River. About 300,000 tons of material would be used. To date, no development of these aggregate deposits has occurred. The deposits have been tested for suitability, but no accurate estimate of the total reserves present has been made. The local demand is satisfied by several private sand, gravel, and aggregate producers in the vicinity. The proposed deposit is within the take line of the Chatfield Dam and heretofore has been in private ownership.

The Stevens Gulch staging area would require the leveling of 4 acres of land. The surface is characteristically open, and gently sloping; rock outcroppings are rare. The gentle slopes of the natural topographic surface would be flattened; gross changes in topographic elevation would probably be less than 25 feet.

Access road improvements would have minor effects on topography except where cuts and fills would be necessary. This would be between survey stations 340 + 50 and 354 + 50, where the old railroad bed would be eliminated. The dam crest road would alter the topographic character on about 4 acres with a hillside cut. There would be additional impacts from this alteration of the topographic character as described in the Visual Resources section of Chapter 3.

Excavation of the proposed Foothills Tunnel would affect the removal of parts of several geologic formations; however, the impact of that operation would be negligible when compared to the broad areas occupied by the formations. This operation should not impact topographic landforms or known mineral resources; however, it would possibly expose some minor ground water aquifers in both sedimentary and metamorphic rock.

Construction and operation of the treatment plant complex would alter the existing landform in that area. Excavation and grading would alter landforms while operational buildings would alter the natural continuity of the landscape. Also, about 4,490 pounds (3 cubic yards) of sludge would be produced daily from the proposed treatment plant operation at 125 mgd; at 500 mgd, the plant would produce 28,500 pounds. This material would be dumped into an abandoned quarry near the plant, possibly resulting in the eventual filling of this quarry and restoration of the original landform.

The trenching operation along Conduit No. 27 and the second parallel conduit would temporarily alter the topography while the 15-foot-wide, 15-foot-deep trench was open (about 3 months). After that, the trench would be backfilled and the natural shape of the land would not be further affected.

Construction of the Foothills Project would result in increased sediment yields from disturbed areas during construction and the ensuing rehabilitation. Table 3-7 summarizes the increased sediment yields from various project components and traces sediment yields through the years that increased erosion would occur. Sediment yield values in the table are based on sediment yield, increasing from the present 0.5 ton per acre to 3 tons per acre. The increase of 2.5 tons per acre during the first year would decrease at a rate of 0.1 ton per acre during each of the following ten years that might be needed for rehabilitation.

New road construction and upgrading of old roads would disturb the soil on approximately 28 acres (not including the rock outcropping) in the canyon. These actions would add 70 tons (0.04 acre-feet) of sediment to the river during the first year and 385 tons (0.2 acre-feet) during ten years, the time estimated necessary for the reestablishment of a vegetation cover. The amount of sediments lost would depend upon storm intensity and the number of high runoff events during any one year. Climatalogical data indicate there are about eleven storms annually during which precipitation exceeds 0.5 inches in one day. Most of the soil loss would probably occur during those storms. Sediments produced from construction in the canyon would be deposited in the South Platte Intake diversion. Water quality and aquatic habitat would be affected between the sediment source and the South Platte Intake.

Additional impacts would result from the installation of powerlines and telephone lines. Five acres of soil and vegetative disturbance would be required during the installation of this project feature, which would increase the sediment yield by 12.5 tons during the first year and 68.8 tons (1.036 acre-feet) during the ten years necessary to reestablish ground cover.

The clearing of vegetation below the high water line in the reservoir area would disturb soils and vegetation on approximately 30 timbered acres. From that portion of the cleared area in the South Platte Canyon (14,800 feet of a total of 16,800 feet), about 88 percent of these sediments, or 60.5 tons, would be deposited in the South Platte River and eventually in the South Platte Intake. This would affect water quality and aquatic habitat in the 2.6 miles of river above the South Platte Intake within the 117 acres characterized by montane vegetation. This would result in an additional 75 tons of sediment per year being deposited in the South Platte River and eventually the South Platte Intake. Since construction would require about three years, the total yield of sediment would be 225 tons (0.116 acre-feet). This would also affect water quality and aquatic

TABLE 3-7

INCREASES IN SEDIMENT YIELD (TONS) BY YEARS

Action	Acres Affected	Present Annual Sediment Yield	Sediment Yield (tons) 1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	Total
Vegetative clearing	30	15	75	75	75 1/									225.0
New road and upgrading	28	14	70	63	56	49	42	35	28	21	14	7.0	0	385.0
Powerline and telephone lines	5	2.5	12.5	11.25	10.0	8.75	7.50	6.25	5.00	3.75	2.50	1.25	0	68.8
East portal	11													
Access road	3	1.5	7.5	6.0	4.50	3.00	1.50	0						22.5
Portal access staging area ponds	8	4	20.0	20.0	20.0	16.0	12.0	8.00	4.00	0				100.0
Treatment plant complex														
Treatment plant site at 125 mgd	135 2/	67.5	167.5	167.5	175.0	140.0	105.0	70.0	35.0	0				860.0
Treatment plant site at 500 mgd	90	45	112	112	117	94	70	47	23	0				575
Total	225	112.5	279.5	279.5	292	234	175	117	58	0				1435.0
Conduit No. 26 and Aurora intertie	10	5	25.0	20.0	15.0	10.0	5.0	0						75.0
Conduit No. 27	105	52.5	262.5	210.0	157.5	105	52.5	0						787.5
2nd Parallel Conduit	105	52.5	262.5	210.0	157.5	105	52.5	0						787.5 3/
													Grand Total:	3,886.3

1/ Dam will be completed after 3 years; area will be inundated or sediment will enter storage area.
2/ See text as to how construction will affect these 135 acres.
3/ This represents 2 acre-feet.

habitat. After construction, the area would be inundated and thus no longer subject to erosion.

Impacts of erosion from the Stevens Gulch staging area should be insignificant because of the high permeability rate of the material that would be used in the construction of the staging area and because most of the 4 acres would be gently sloping to flat. As an added measure, a retention dam would be constructed below the staging area to intercept any sediment from the area.

Of the 30 acres to be disturbed in the east portal area, only 11 acres would be subject to soil losses from surface disturbance. The remaining 19 acres, planned for soil disposal, would have no impact because a berm and drainage ditch would be constructed around the area to channel sediment into an adjacent retention pond. Under the proposal, no sediment would be allowed to enter Little Willow Creek.

Within the 11 acres that would be disturbed by construction, about 4 acres would be in the staging area and 2 acres at the portal access. Over a five-year period, 22-1/2 tons (0.012 acre-feet) of sediment would be yielded from the access road. Sediment yield is based on the assumption it would take five years to reestablish ground cover.

The portal access, staging area, and pond areas would yield 100 tons (0.052 acre-feet) of sediment over a seven-year period. Erosion would take place during construction (three years) and then during an additional five years, until a ground cover is established. Sediment from these areas would enter Little Willow Creek, which flows into the Highline Canal.

Soil and vegetation disturbance associated with construction at the 125 mgd treatment plant complex would occur on 145 acres: 10 acres for Conduit No. 26 and the Aurora intertie and 135 acres for the treatment plant. At any one time, about 50 percent of the area needed for the 125 mgd treatment plant would be disturbed and subject to erosion during the three-year construction period. This area would yield 167.5 tons of sediment annually, a total of 335 tons (0.173 acre-feet) over the three-year construction period. After construction, 65 acres of this complex would be occupied by buildings, ponds, and pavement and would not be subject to erosion. The remaining 70 acres would yield 525 (0.271 acre- feet) tons of sediment over a five-year period.

The 10 acres of disturbance from Conduit No. 26 and the Aurora intertie, which are part of this complex, would yield 75 tons of sediment during the five-year reestablishment period.

Detailed site planning is not completed on the second, third, and fourth 125 mgd increments; therefore soil and vegetation disturbance associated with expansion to 500 mgd cannot be discussed here except in general terms. Ninety acres of soils would be disturbed between the years 1983 and 2001, yielding a total of about 575 tons of sediment. During this time, 204 acres of vegetation would be disturbed; of these, 114 acres would be permanently occupied by structures (Tables 3-7 and 3-8).

The disturbed area in the treatment plant complex for both 125 and 500 mgd levels would be 1,435 tons (0.75 acre-feet) of sediment. This area would be subject to wind erosion also, but no data are available at this time to quantify this impact.

With the installation of Conduit No. 27, approximately 105 acres of soil and vegetation would be disturbed over a period of three years. About 8.5 acres would be disturbed each month, with an average lag time of three months before rehabilitation would begin to take place. Approximately 787.5 tons (0.407 acre-feet) of sediment would be yielded from the 105 acres during the five years for revegetation and the four-month lag time when the area would be constantly disturbed. Of the 787.5 tons of sediment from the pipeline, 47 tons would enter Willow Creek; 292 tons would enter Plum Creek, which flows into Chatfield Reservoir; 73 tons would flow into Spring Creek drainageway, which flows into Plum Creek; 71 tons would flow into Marcy Gulch, a tributary to the South Platte River; 180 tons would flow into Dad Clark Gulch and Clark Creeks, which flow into McClellan Reservoir; and 129 tons would flow into Little Dry and Dry Creeks.

The second parallel conduit would also disturb 105 acres of soils between the years 1983 and 2001, also yielding 787.5 tons of sediment as did Conduit No. 27. During five years for revegetation and a four-month period of continuous soil disturbance, 210 acres of vegetation would be affected but would be completly restored (Tables 3-7 and 3-8).

There would also be some minor erosion due to wind along Conduit No. 27 and the second parallel conduit, but no data are available to quantify the impacts.

Although data are not available to measure soil loss due to the project beyond ten years, the loss of 3,886 tons (2.4 acre-feet) of soil from 330 acres in the project area would probably not noticeably reduce long-term soil productivity. Vegetative reestablishment might be reduced slightly, but the effect would hardly be measurable.

TABLE 3-8

VEGETATION DISTURBANCE OF THE FOOTHILLS PROJECT
DURING THE LIFE OF THE PROJECT

Construction Area and Zone	Acres Disturbed Permanent	Acres Disturbed Temporary	Temporary Disturbance Time	Years Required for Revegetation 1/	Total Acres
Reservoir	117				117
Stevens Gulch access road	5	5	(5 mos.)	10	10
Dam crest road	2	2	(5 mos.)	10	4
Dam base road	3	-	(5 mos.)	10	3
Road above reservoir	1	1	(5 mos.)	10	2
Concrete aggregate	-	150	(2 yrs.)	5	150
Stevens Gulch portal and staging area	-	4	(2 yrs.)	10	4
East portal	-	30	(2 yrs.)	5	30
Tunnel	-	-	-	-	-
Treatment plant complex					
125 mgd	65	80	(2 yrs.)	5	145
500 mgd	114	90	(2 yrs.)	5	204
Total	179	170			349
Powerlines and telephone lines and roads	-	5	(6 mos.)	10	5
Conduit No. 27 and 2nd Parallel conduit (native vegetation)					
125 mgd	-	85	(3 mos.)	5	85
500 mgd	-	85	(3 mos.)	5	85
Total		170			170
Conduit No. 27 and 2nd Parallel conduit (cropland)					
125 mgd	-	20	(3 mos.)	1	20
500 mgd	-	20	(3 mos.)	1	20
Total		40			40
Sludge disposal	-	5	(1 yr.)	5	5
TOTAL	307	582			889
Summary by Vegetation Zones					
Riparian zone	27	5		10	32
Montane zone	101	12		10	113
Grassland zone (native)	179	525		5	704
Grassland zone (cropland)	-	40		1	40
Total acreage	307	582			889

1/ Years required to reestablish ground cover, stabilize the soil, and tree and shrub growth.

Vegetation

Construction of the reservoir and ancillary facilities in the Waterton Canyon would destroy 136 acres of vegetation, 128 of which would be permanently lost to production because of reservoir clearing and permanent roads (Table 3-8). About 100 large Douglas fir, pine, and cottonwood trees would be affected.

As noted in Table 3-8, the 582 acres of temporarily disturbed vegetation would be completely lost for periods varying from three months, in the case of Conduit No. 27, to two years, in the case of the portals and treatment plant complex. It would require about five years for disturbed areas in the grassland zone to reestablish the ground cover and stabilize the soil and ten years for disturbances in the montane and riparian zones.

The permanent loss of 27 acres of riparian habitat would be partially offset by a gain of 12 acres of riparian vegetation that would naturally establish along the shoreline and 1 acre of riparian vegetation which would reestablish in Stevens Gulch in about ten years. There would be a net loss of 14 acres of riparian vegetation and ten years of habitat loss.

Wildlife

The significant adverse impacts on wildlife species would occur from the loss of wildlife habitats, especially the highly productive riparian sites, and their associated carrying capacities and human harassment during construction, especially of the dam, tunnel, and roads. The entire Waterton Canyon would be adversely affected. The smaller, less mobile species such as rodents and reptiles would not be able to relocate in other areas and would be lost because of the lack of unoccupied niches. Larger, more adaptable species such as deer, bobcats, sheep, and bear would probably shift to less intensely disturbed areas. Many of these displaced animals would also be lost because of their movement into less productive sites, competition with existing populations and greater susceptibility to predation. Wildlife losses would affect aesthetic and recreation values.

After construction, most species could return to the areas which had been temporarily disturbed. Other areas would be permanently altered by construction or by being inundated with water from the reservoir. These areas would be totally altered as forms of wildlife habitat. Because of the revegetation of the reservoir's shoreline,

the overall change in the area's biomass is expected to show only a small net increase. The return to near preconstruction conditions would depend on the amount of human use allowed in the canyon after construction. Although the canyon would be closed to recreational use during construction, present plans are to reopen the canyon afterward. The reservoir could attract additional visitors who would not use the area without the reservoir. Features such as the temporary access routes and maintenance of all features would not cause permanent adverse impacts.

Bighorn Sheep

The loss of vegetation resulting from this project would probably not impact the bighorn sheep; however, the primary impact of constant harassment and noise associated with the construction work over a three-year period could completely drive bighorns out of the lower sections along the stream and force them to concentrate away from the intense activity. The human harassment and noise of blasting and heavy equipment would disrupt the entire range of the bighorn, but the sheep would probably have to remain in the canyon since surrounding areas are not only heavily impacted by humans but are also unsuitable habitat.

The negative effect on the sheep would probably not be immediate, but loss of traditional lambing areas and breeding and wintering areas (Map 2-7) could reduce the herd's lamb crop, as was speculated by Jones and Jones (1974) (Appendix 1) to have happened during construction of the Waterton Canyon Intake in the 1960s. Harassment could cause changes in behavior, including interruption or discontinuance of breeding habits, and therefore affect reproduction and recruitment. More recent data, cited in Chapter 2, indicate that disease caused by crowding and stress may be an even more serious decimating factor. The incidence of lungworm-induced pneumonia increases with crowding; however, losses from the disease may be delayed for several years.

The impact on the sheep herd from all sources could result in a 50 percent herd reduction in Waterton Canyon (personal communications, Foothills ES Fish and Wildlife Subwork Group). The entire 60- to 65-head could be lost as a result of this project, but it is more probable that the herd would be reduced to 30 head. Loss of bighorns would adversely affect recreation and aesthetic values in the Waterton Canyon.

Endangered Species

The project will have no adverse effect on any endangered species (see appendix 3).

Other Protected and Game Species

If initial road construction in the Platte Canyon were to begin in March or April, as indicated in Figure 1-3, it is possible that one golden eagle eyrie with eggs and/or young could be deserted. The net result would be the loss of that nesting cycle for one year for one pair of eagles. If the nesting cycle were successful, one or two young would probably be reared. The eagles would probably nest in unoccupied eyries away from the disturbance during the next two construction seasons and reoccupy the sites soon after construction ceased. However, due to the large number of people now using the area, the eagles are accustomed to the people pressure and would probably continue to use these nesting sites. Golden eagles, as well as other birds of prey, would eventually benefit from the prey species attracted to the reservoir and treatment plant area.

The reservoir would provide habitat for birdlife which frequent larger bodies of water. Examples of these species are blackbirds, swifts, swallows, waterfowl, grebes, gulls, wading birds, and shorebirds. The poor productivity of the reservoir caused by the steep rocky sides would reduce the number of birds which the impoundment could support. If heavy recreational use would also occur, only those species of birds which are tolerant to human disturbance would remain. The treatment plant site would alter existing habitat by providing water impoundments which would attract water-dependent birdlife. The increase in species diversity would benefit (to a slight degree) those raptors which prey upon birds.

Raptors and other birds could be injured or killed by electrocution or by flying into the powerlines. Proper design will prevent electrocution, but nothing will prevent them from flying into the lines.

Deer, mountain lion, and black bear would be disturbed and driven from the South Platte Canyon and Stevens Gulch by construction activity. Another probable form of big-game loss would result from illegal harvesting. Historically, during large-scale construction projects in the western United States, some degree of illegal harvesting has taken place. Because of this historic trend, it would be prudent to assume that similar activity could take place during the construction phase of the proposed action unless proper safeguards were taken.

Construction of each of the two segments of Conduit No. 27 and the second parallel conduit would temporarily disturb 85 acres of grassland vegetation and 20 acres of cropland, bisect two prairie dog colonies, and possibly temporarily dislodge antelope from part of 3,000 acres (approximately 8 percent) of their range north and west of the conduit near the Highlands Ranch (Map 2-7) for about ten months. The impact on these species would be very slight and temporary. The few prairie dog burrows which would actually be excavated (approximately 100) would be less than 0.1 percent of the burrows in the general area. As evidenced in the recently disturbed area along the Aurora pipeline, prairie dogs would return to the disturbed area, possibly in increased numbers, after the three-month disturbance.

Fire

The risk of man-caused fire would increase as construction activities increase. In all probability, an average of one man-caused fire per year would occur during the construction period. After completion of all construction, the man-caused fire risk would be reduced but would gradually increase as more people visit the canyon. Fires would not be expected to be very large in the area based on past history, but under the right weather and fuel conditions a major fire could occur in the area.

CLIMATE AND AIR QUALITY

Construction and operation of the proposed Foothills Project would not measurably change the climate of the Foothills area. Construction activities could yield several types of air pollution: dust from earthmoving operation, dust from unpaved roads, and emissions from earthmoving vehicles and trucks. These are direct, short-term impacts that would affect the Foothills area for about 30 months. Air quality would not be measurably decreased as a result of the operation and maintenance of any aspect of the proposed project.

On the unpaved access roads, dust created by vehicles hauling concrete aggregate would occur primarily during April through September for two consecutive construction seasons. An estimated 20 truckloads of concrete aggregate per day would be hauled to the dam site during that period. Typically, concrete aggregate would be hauled to the dam site during the daylight hours. Estimates are that the net effect of dust from hauling and earthmoving would increase over the ambient air quality levels in the primary impact zone by less than 10 percent. The effects outside the primary impact zone would not increase enough so they could be measured.

According to a memorandum from the Colorado Air Pollution Control Division, "The construction and operation, in itself, of the proposed water diversion and treatment facilities or their alternatives should have minimal impact on regional air quality. Mitigating measures are available to reduce the air contaminants released during both onsite construction and operation of the facilities. The pollutant of primary concern is particulate." (Colorado Department of Health 1977)

Use of construction vehicles would result in emissions. Because of the increased number of vehicles in the area, emission would increase during peak construction activities (six months for each two consecutive seasons). This increase in emissions is not expected to reach levels that would be hazardous to human health or measurably affect vegetation in the primary impact zone.

The production of ozone from any proposed powerlines could become an environmental problem if voltages exceeded 345 kilovolts. The low voltage transmission and powerlines on this project (13.2 kilovolts) would not result in ozone production that affects plants, animals, or man.

Slight increases in fugitive dust from construction activities of Conduit No. 26 and the proposed treatment plant could not be measured. Effects of the proposed laying of Conduit No. 27 and the additional conduit necessary for the treatment plant to operate at 500 mgd would be identical.

If chlorine were accidentally spilled, the chlorine, a heavy greenish-yellow irritating gas with a pungent odor, would vaporize and, being heavier than air, concentrate next to the ground. The gas would drift with the wind or would flow downslope like water and concentrate in low areas. Since the prevailing winds and drainage systems move from south to north, air quality conditions would be seriously degraded in the southern Denver metro area and emergency measures, including evacuation of residents from the affected area, would have to be implemented to prevent injury and illness. The number of injuries occurring as a result cannot be quantified.

Accidents resulting in spilled ammonia, a pungent colorless gas, would introduce an irritating odor into the air in the vicinity of the spill. However, since ammonia is lighter than air, it would rapidly mix and dilute in the atmosphere. Workers and residents in the vicinity of the spill and downwind from it might have to be evacuated from the affected area to avoid injury.

The impacts of spilled toxic chemical gases would be magnified to an unknown extent if the accident occurred during an inversion. Under inversion conditions, gases would be trapped and concentrated. The resulting impacts on residents of the area would be extended until the inversion broke up and the toxic gases escaped to or mixed with the atmosphere.

NOISE

Construction within the canyon would raise noise levels to the range of 80 to 90 dBA (decibels, adjusted) at 50 feet from the equipment. Blasting, drilling, and earthmoving required for the construction of these portions of the project would create a disturbance in the canyon and foothills, which now have ambient noise levels ranging from 32 to 60 dBA. These machines and their approximate sound-generation levels are listed in Table 3-10. Figure 3-4 depicts noise contours for all phases of construction.

Traffic to the construction area would create additional noise in the canyon and around the Kassler Treatment Plant. Road-building equipment, trucks, and buses would generate noise during the three years of construction. Because workers would arrive at the Kassler parking area in three shifts, this noise would not be confined to normal working hours.

The Stevens Gulch staging area would be noisy. If the contractor elected to mix concrete at the staging area, this process, together with the sound of trucks delivering aggregate plus the general noise generated by the construction of the dam, would raise the ambient sound level at this location to about 85 dBA. The resulting noise levels within the canyon would harass and to some degree displace, at least temporarily, many of the wildlife species found near the canyon bottom. Outside the immediate canyon, the effects of the noise would be negligible.

Blasting would be required for construction of the access road. Although it is not known to what extent sudden, loud noise effects wildlife, the birds and animals in the canyon and foothills probably would be adversely affected by the blasting. Some of this noise would also be audible to people in the Kassler Treatment Plant area and possibly at Roxborough Park. Although blasting would be periodic and infrequent, it would reach an estimated 105 to 125 dBA at the source (DWB 1974).

Although much of the equipment listed in Table 3-10 would not be operated simultaneously, sound levels could reach about 90 dBA during construction. This would be perceived as eight times louder than the existing sound level (DWB 1974).

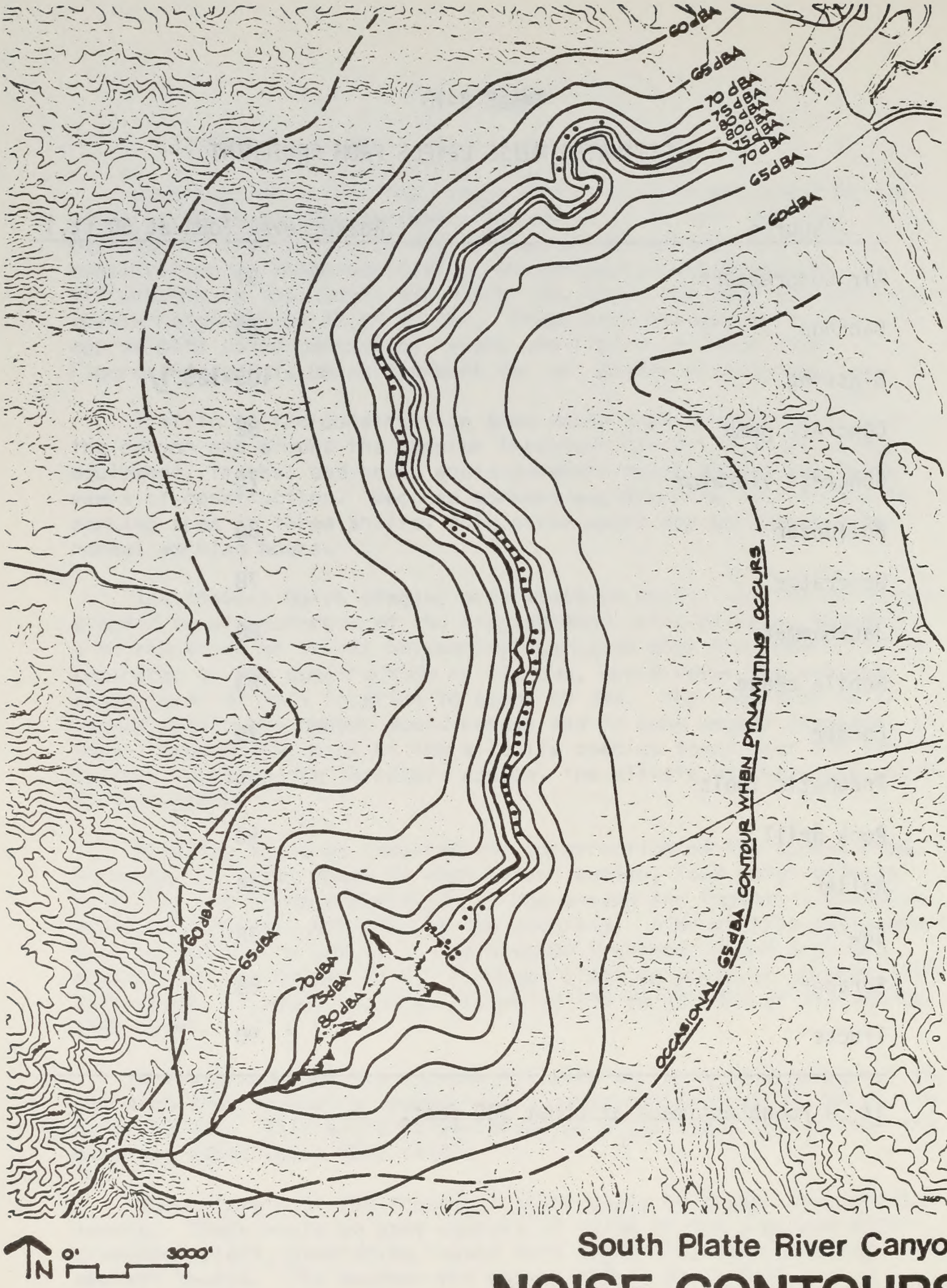
Noise levels at the treatment plant would be higher than present levels. There would be many sources of noise at the proposed water treatment plant, generating levels much higher than the existing ambient levels. The sources are enumerated in Table 3-11.

TABLE 3-10

ESTIMATED NOISE LEVELS FROM EQUIPMENT

Source	Noise Level (dBA at 50 ft.)
Air Compressors	81
Backhoe	85
Blasting	105-125 1/
Concrete pump	82
Concrete vibrator	76
Bulldozer	80
Generator	78
Jackhammer	88
Mobile crane	83
Loader	79
Pneumatic tools	85
Rock drill	98
Roller	74
Saw	78
Scraper	88
Trucks	90

1/ A rough estimate at about 500 feet.



South Platte River Canyon

NOISE CONTOURS

2 Year Construction Period

FIGURE 3-4

TABLE 3-11

SOURCES AND PROBABLE LEVELS OF NOISE AT PROPOSED FOOTHILLS TREATMENT PLANT

Sources	Noise Level (dBA at 3 ft.)
Energy dissipation valves	85
Rapid mix drives	83
Washwater pumps	92
Boilers	86
Exhaust fans	82
Engine generators	96
Overhead cranes	83
Flocculator drives	78
Sludge collector drives	78
Chemical feeders	78
Filter surface wash pumps	86
Plant service water pumps	83
Chemical mixers	78
Air compressors	95
Air conditioning unit	89
Personnel vehicles	65 1/
Delivery trucks	85 1/

DWB 1974.

1/ At 50 feet.

Most of the equipment employed in the treatment plant operation would be housed in concrete structures. The noise levels transmitted to the property line from this equipment, operating indoors, would reach only 40 dBA, about the same as the present ambient level.

After completion of the dam and reservoir, the sound level in the reservoir area would be reduced from present levels. A tranquil pool would replace the rushing river upstream of Strontia Springs. The dam would buffer the sound of regulating valves. Estimates are that the ambient sound level near the water in this area would be reduced from 60 to 50 dBA.

Sound produced by discharge from the dam's regulating valves would be continuously loud. Levels ranging from 85 to 95 dBA would exist next to the dam; 4,000 feet downstream levels would diminish to 60 dBA. Because the dam would block much of the noise, the level 40 feet upstream would be only 60 dBA (DWB 1974). Although this noise would adversely affect recreational use near the dam, it would not have a significant impact downstream from Stevens Gulch.

Construction of Conduit No. 26, the power generation and treatment plant would create higher sound levels than exist today. The equipment used in construction of the proposed water treatment plant is similar to that used in the canyon. The noise levels generated by this machinery range from 85 to 95 dBA at a distance of 50 feet. The Roxborough Park community would probably receive levels of about 50 dBA. Construction noise would vary over the building period. The noise levels would probably have little or no effect on the wildlife or human populations in the immediate vicinity. The 50 dBA noise level in Roxborough Park would be hardly noticeable.

As a result of workers and equipment using surrounding roads for access to the plant site, traffic might increase on adjacent roadways now lightly traveled. Some additional traffic noise thus would be generated in the surrounding community (DWB 1974). These impacts are not considered significant.

Noisy equipment would be used in laying Conduit No. 27 and the second parallel conduit. The backhoe, bulldozers, and scraper equipment used in construction would generate noise levels of 80 to 85 dBA. This sound level is considerably higher than existing levels.

Some temporary disturbance would result in the developed residential areas, but, owing to the relatively short time involved in any one location (work would progress at about 115 feet per day) and the presence of other similar activities, the impacts would not be significant.

Noise levels associated with power generation when the plant is operating at both 125 mgd and 500 mgd levels are unquantifiable but

are considered insignificant because power generation facilities are encased in concrete structures and are below ground level.

VISUAL RESOURCES

Due to the proposed closure of the Platte Canyon during construction, only the short-term visual impacts resulting from construction of the water treatment facility and conduits would be realized. Because of this, the discussion of short-term impacts will be limited to those features.

The visual impacts of a proposal on an area can be measured by their relative contrast with the existing landscape. The contrast would vary with the specific elements of the proposal, the specific locations of those elements, and the existing landscape as described by physical attributes.

Contrast is assessed in terms of how the proposal is expected to affect existing physical attributes--landform, vegetative patterns, and existing structures such as powerlines and buildings. Anticipated changes in form, line, color, and texture are analyzed individually in reference to landform, vegetative patterns, and structures. The resulting contrast ratings are compared to the maximum contrast limit for the particular visual management class indicated for the land affected by the proposal (see Maps 2-8, 2-9, 2-10, and 2-11 at the end of Chapter 2).

As indicated in Tables 3-12 and 3-13, the specific elements resulting in visual contrasts are inundation, the Strontia Dam, the 22-foot standard dam access road, the 22-foot standard road widening, the 12-foot standard road widening, Stevens Gulch staging area, the powerlines and telephone lines to the dam site, the water treatment facility, and Conduit No. 27 and the second conduit parallel to it. A description of visual contrast generated by each element follows.

Inundation

Inundation in the Waterton Canyon behind the Strontia Springs Dam would radically change the landscape. Instead of a narrow, steep-walled, rocky canyon with the South Platte River dominating the landscape, there would be a placid lake with steep, rocky hills along its shoreline. The strong sense of enclosure would be relatively unchanged at the west end of the reservoir but greatly diminished near the dam site.

Although this would constitute a radical change, the resulting landscape would also be pleasing to the eye. The anticipated drawdown is so small that it should not significantly affect the visual integrity of the proposed shoreline.

TABLE 3-12

ANTICIPATED VISUAL IMPACTS
DURING CONSTRUCTION PHASES

Rated Element	Anticipated Visual Contrasts: Landform	Vegetative Patterns	Structures	Visual Management Class Maximum Contrast Limit
Water Treatment Facility	23	18	27	24
Conduit No. 27	22	20	18	24
2nd Parallel Conduit	22	20	18	24

TABLE 3-13

ANTICIPATED VISUAL IMPACTS AT YEAR 2001

Rated Element	Anticipated Visual Contrasts: Landform	Anticipated Visual Contrasts: Vegetative Patterns	Anticipated Visual Contrasts: Structure	Visual Management Class Maximum Contrast Limit
Inundation	7-13	12	NA	16
Strontia Dam	30	NA	30	16
22-foot Standard Dam Crest Road	17	20	NA	16
22-foot Standard Road Widening	25	18	NA	16
12-foot Standard Road Widening	23	NA	NA	16
Stevens Gulch Staging Area	17	10	21	16
Powerlines and Telephone Lines to Strontia Dam Site 1/	6	7	22	16
Water Treatment Facility	12	27	25	20
Conduit No. 27	13	10	7	20
Second Parallel Conduit	13	10	7	20

1/ Assuming a line constructed with minimum clearing and no mechanized leveling.

Flow schedules in the upper South Platte are assumed to remain the same and, therefore, impacts on visual resources upstream from the proposed project will be concentrated in the river's North Fork up to Roberts Tunnel. These impacts would occur when the plant is operating above the 125 mgd level and would be a result of increased flows from Roberts Tunnel. The specific flows and resulting impacts will depend upon future means of obtaining the additional raw water that will be needed beyond the 125 mgd level. The drawdown on Dillon Reservoir and the resultant visual impacts would also depend upon future raw water sources.

Strontia Springs Dam

This part of the proposed action would impose a massive man-made feature on a relatively undisturbed landscape. As is illustrated by Figure 3-5, the dam would abruptly end the linear continuity of Waterton Canyon. It would dominate the landscape at that point due to its size and location.

The dam would produce high contrasts with the existing landscape in terms of landform, line, color, and texture, (the four basic elements used by the BLM to determine contrasts between proposed changes and the existing landscape). Table 3-14 shows a comparison of the physical characteristics of the existing landscape and the proposed dam.

The contrasts shown in Table 3-14 are evident at Cheesman Dam (Figure 3-6). Although more vegetation is present and the face of Cheesman Dam is stone masonry, the impact would be similar.

Although the Strontia Springs Dam would generate a visual contrast generally considered to be too high by BLM standards (Table 3-13), such a structure is both graceful and impressive. Its construction would still destroy the natural landscape within its view.

Dam Crest Road

This road would not be entirely visible from the floor of Waterton Canyon or the surface of the reservoir. It would be plainly visible, however, where it enters the visual corridor. At that point it would be a linear, cleared scar traversing a timbered, steep slope on a prominent part of the canyon wall (Figure 3-7). Because the road is above the point of observation, the roadbed itself would not be visible.

Figure 3-5 Site of the proposed Strontia Springs Dam.

TABLE 3-14

VISUAL COMPARISON OF THE EXISTING LANDSCAPE AND THE PROPOSED STRONTIA SPRINGS DAM IN TERMS OF LANDFORM

Element	Existing	Strontia Springs Dam
Form	Jagged, blocky, enclosed corridor effect is strong	Flat, gently curved, wall-like, abruptly ending the visual corridor
Line	Angular with very strong convergence, broken ridgeline	Vertical and horizontal linear grid on face, horizontal linear top, smooth concavity on face, strong convergence
Color	Dark grey, black, green, red-brown	Light gray
Texture	Coarse	Smooth

Figure 3-6 Cheesman Dam: example of a dam structure located within scenery comparable to that of Waterton Canyon.

Figure 3-7 Rocky point that would be traversed by the proposed dam crest road.

Road Widening

The existing access road is the feature in Waterton Canyon from which visual impacts of the proposal would be viewed. Because of this, modifications of the existing road that create visual impacts would be very evident and are likely to dominate in the foreground. As shown in Figure 3-8, a road built with a 22-foot driving surface and its associated cut into the rocky canyon wall would result in high impacts on the landform in terms of form and color and moderate impacts online, created by both the rock and soil cuts and the significantly larger road. The anticipated impacts of the road widening proposals are shown in Table 3-9. Examples of the existing road proposed for widening are shown in Figure 3-9 and can be compared with the existing 22-foot standard road shown in Figure 3-8.

Staging Area

The landscape resulting from construction of the staging area would be quite different from the existing conditions (Figure 3-10). When viewed from the existing road in the Platte Canyon, the finished staging area would produce impacts similar to those discussed for the Strontia Springs Dam. Several factors reduce the impact of the staging area compared to that of the Strontia Springs Dam. The retaining wall/tunnel access structure is considerably smaller than the Strontia Springs Dam.

Stevens Gulch at the proposed staging area site does not have the near vertical side-slopes found in Waterton Canyon. The texture of the landform is more compatible with that of the proposed staging area. The staging area would be overshadowed by the visual impact of the dam.

Powerlines and Telephone Lines

Construction of a combined powerline and telephone line to the dam site would generate high visual impacts from the structural standpoint (Table 3-13). This impact would be mainly caused by the imposition of a structure with strong linear characteristics on a landscape that has no such structure presently visible (Figure 3-11). The impact on the linear characteristics of the Waterton Canyon as well as contrasts in color would be intensified if reflective wire were used.

Figure 3-8 Existing access road constructed to a 22-foot standard in Waterton Canyon.

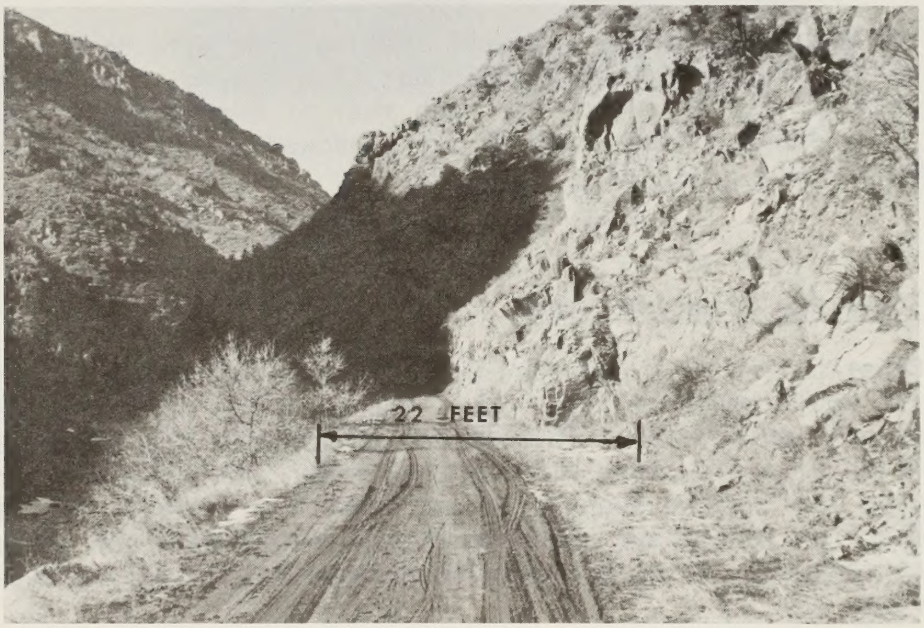


Figure 3-9 Segment of road proposed for widening to a 22-foot standard. The existing road is 10 to 12 feet wide.

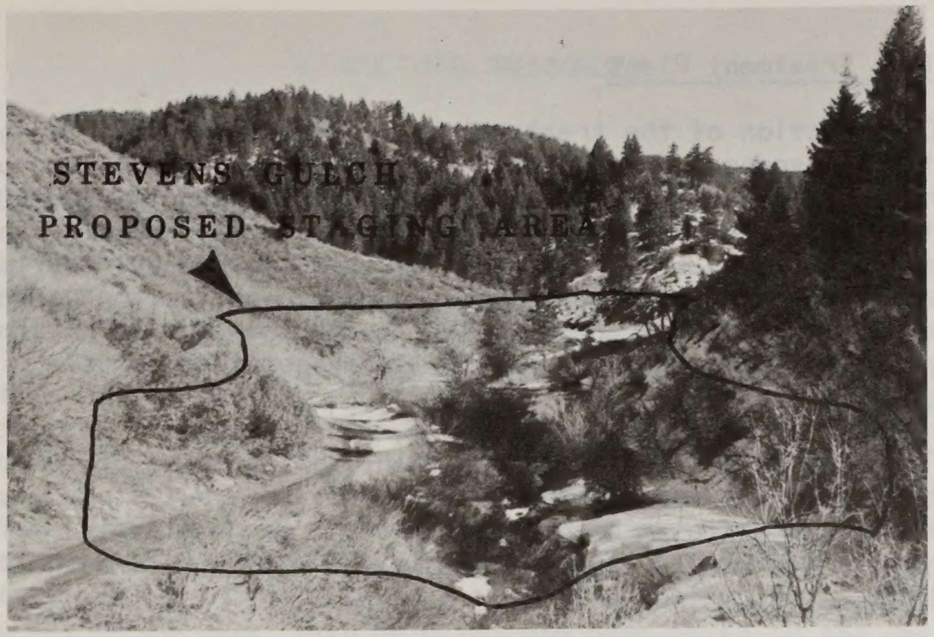


Figure 3-10 Stevens Gulch at the site of the proposed staging area.

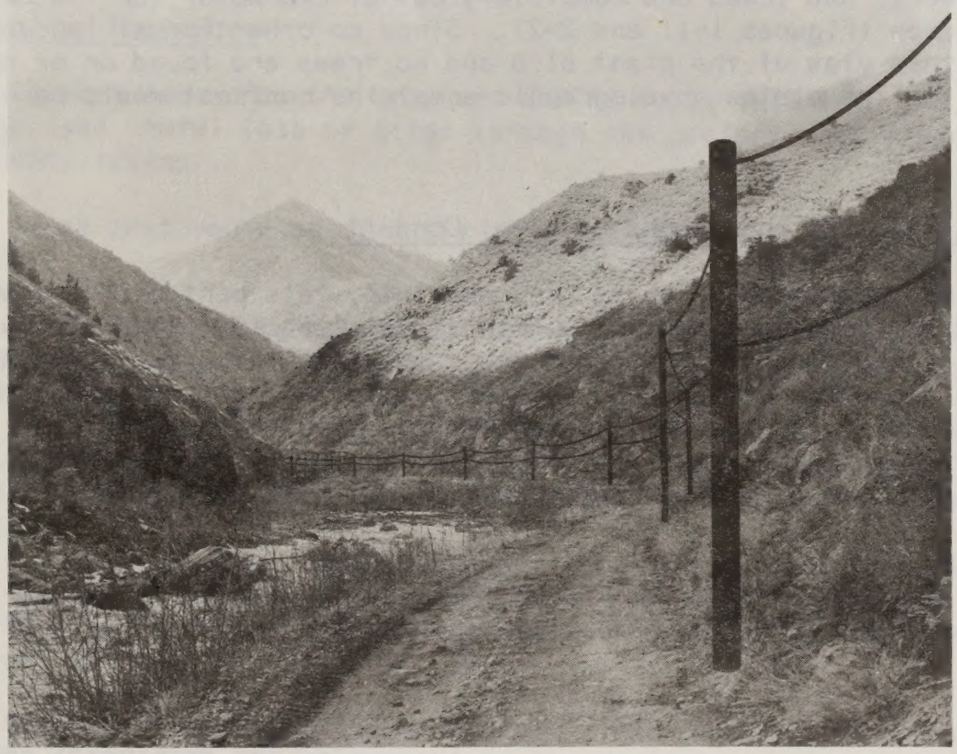


Figure 3-11 Segment of Waterton Canyon included in the proposed power and telephone line route.

Foothills Treatment Plant

Construction of the treatment plant would radically change the existing landscape. The general impact would be the conversion of a presently undeveloped, sloping tract of land, shown in Figure 2-4, to a partially-leveled tract covered with structures, asphalt, and formal landscaping (Figure 1-11). As indicated in Table 3-2, the visual contrast levels anticipated to occur during construction would be in excess of visual management contrast limits from the structural standpoint, but not from the landform or vegetative pattern standpoint.

The impacts on landform would mainly be in terms of form. Extensive leveling would occur in the area where buildings would be constructed. However, the present landform is relatively flat with gently rolling terrain, so the contrast is considered moderate rather than high.

As shown on Table 3-13, long term visual contrasts concerning vegetative patterns would exceed visual management class limits. This is due to the addition of shapes foreign to the vegetative patterns in the form of structures, asphalt covered areas, and form landscaping. In addition to the shape of the formal landscaping, the grass, shrubbery, and trees are completely out of character for the existing landscape (Figures 1-11 and 2-2). Since no other formal landscaping is within view of the plant site and no trees are found on or near the site (on the plains physiographic area) the contrast would be high.

Conduit No. 27 and Second Parallel Conduit

As indicated on Tables 3-12 and 3-13, this part of the proposal would not produce excessively high visual impacts. Sensitivity of the area is low because of the number of existing intrusions, the Aurora Conduit and Conduit No. 85, suburbs, railroads, and a highway. Because of this, the anticipated impacts of both conduits are relatively low.

CULTURAL RESOURCES

Archaeological Resources

No archaeological sites have been identified at the dam site, impoundment, access route or staging areas. Only one greatly disturbed lithic matter was uncovered throughout the length of conduit No. 27. Therefore, no significant impacts from construction or operation activites are predicted for these areas other than potential impacts upon resources which are currently obscured by present overburden.

Construction of the treatment plant could have extensive impact upon archaeological resources. The lithic material occurring generally over the plant site area would be destroyed, removed, scattered, or buried. This material has been noted by the Colorado State Archaeologist as containing two significant archaeological sites and may possibly contain some significant archaeological resources as yet unidentified.

Historical Resources

Impacts caused by the proposed action would fall into two categories: total loss of sites through the project, and minor, secondary losses.

Sites that would be directly affected by the proposed project follow:

DSP&P Railbed (in Waterton Canyon). This site would be inundated by the proposed dam. About 5.5 miles of rail alignment would be permanently lost.

Deansbury Station and Strontia Springs. This site, which is in ruins, would be lost through inundation by the proposed dam site.

Telegraph Poles. These sites would be lost on a selective basis. The loss may occur through flooding caused by the proposed dam site, and there may be some loss through destruction with the improvements made on the road.

Railway Bridge (Deansbury Bridge). This site would be lost through inundation and/or removal by the project, depending on DWB needs.

Keystone Bridge. This structure, eligible for the National Register of Historic Places, could be maintained through removal.

Denver and Rio Grande Rockwork. This site would, by and large, be lost through inundation of the area by the proposed project.

Consultation and preparation of mitigation and a 106/2b statement for the sites outlined in Chapter 4 have been initiated with the Colorado State Historic Preservation Officer and the Advisory Council on Historic Preservation pursuant to 36 CFR 800.

Paleontological Resources

Excavations at the treatment plant site and along Conduits No. 26, 27, and the second parallel conduit could potentially encounter fossils and other materials of paleontological interest. Excavation activities would probably damage or displace fossils located in the 15-foot wide trench for Conduits No. 26 and 27 and the second parallel conduit and on approximately 204 acres at the treatment plant site.

RECREATION RESOURCES

Recreational impacts in Waterton Canyon are of two types: those temporary impacts that will occur during construction and those that are permanent and will continue after the dam and reservoir are in place.

For safety reasons, the canyon would be closed to all recreational activity during the construction period, probably for about three years. This would mean a loss of at least 30,000 to 60,000 recreational visits (estimated 10,000 to 20,000 in 1976). These losses would be expected to be absorbed by other recreational resources along the eastern foothills of the Front Range. It is unlikely that one specific site that combines all of the attributes of Waterton Canyon could be found. This could have an adverse impact on these areas if they were not capable of sustaining additional use.

The presence of construction workers and noise associated with construction activity probably could cause those animals and birds that require solitude, especially bighorn sheep, to move out of the general area. The quality of any subsequent recreational experiences would then be diminished to the degree that wildlife would not return to the area after completion of the construction. Overall, the project is expected to result in a loss of 50 to 100 percent of the bighorn sheep herd.

A number of much more serious permanent impacts on the recreational resource would follow once the dam and reservoir were in place. Construction of the dam and filling of the reservoir would permanently alter or destroy many of the canyon's unique and impressive natural characteristics sought out by recreationists. The scenic values described in the discussion of aesthetics, which are an important part of the recreational opportunities associated with the canyon, would be severely altered. In the area of the dam and reservoir, the general setting for enjoyment of recreational activities would be transformed from the present one of relatively natural remoteness, enhanced by the rushing stream, into one dominated by a dam and a placid reservoir surface.

Removal of vegetation in the reservoir area and subsequent filling of the reservoir would affect recreational activities. In particular, habitats for wildlife would be lost and both numbers and species decreased, including bighorn sheep. This would have an effect on the enjoyment of such activities as nature study, photography, bird watching, sightseeing, walking for pleasure, and hiking.

In addition, the dam would present a permanent imposing barrier to recreational traffic through the canyon. Recreationists would have

to leave the canyon bottom and traverse the side slopes above the dam and reservoir. Through-bicycle traffic would be severely curtailed. The use of the South Platte River in Waterton Canyon for kayaking would be lost to future use.

Building the dam and filling the reservoir would cause the loss of the remnant features of the narrow gage railroad and end any future consideration of its restoration for tourism and recreational purposes.

The reservoir would eliminate 1.7 miles of stream that now provide opportunities for high-quality trout fishing. Strontia Springs would be a terminal storage reservoir and, therefore, it is probable that no boating, fishing, or swimming would be allowed. The steep terrain surrounding the reservoir would prevent most other uses except hiking. Loss of this area to most recreational uses may result in a decline in the total number of visitors to the canyon. However, since the lower canyon below the dam is capable of supporting additional use, there may be more intensive use of this area without a significant loss in the total number of visitors. Any resultant loss of visitors seeking recreation cannot be quantified.

At least initially, the dam and reservoir would be a curiosity that might attract a large number of people to the area. Unless carefully controlled, this would certainly bring about a decrease and possibly a loss of those species of wildlife that cannot abide frequent contact with humans.

These impacts would occur at random in areas near the reservoir, since no trails are planned to assist in control. These impacts would extend along the access road for the length of the canyon in both directions from the reservoir.

Widening and surfacing of the remaining unimproved portion of the access road would temporarily add to the stream's turbidity, eliminate the important streamside fish and wildlife habitat, and, on the landward side of the road, further decrease the natural appearance of bordering slopes. Any of these things would lower the quality of subsequent recreational experiences.

The extent to which powerlines and telephone lines would detract from the natural setting and enjoyment of the canyon would depend on their alignment and design. The greatest distraction to recreationists would occur where the lines and poles are easily visible from the canyon floor.

Treatment plant construction activity would disrupt the presently unbroken landscape and somewhat diminish the present attraction of the area for occasional sightseeing and driving for pleasure. The quality of recreational experiences in the future Roxborough State Park might

be somewhat decreased by greater numbers of people, traffic, and noises associated with construction. Once constructed, the treatment plant would begin to break the relatively natural setting east of Roxborough State Park. As other future intensive developments encroach on the area, the impact of the plant and associated power-generation activities would become less and less obtrusive.

Disrupting the unbroken, rolling grassland during construction of Conduit No. 27 for operation of the plant at 125 mgd and the second parallel conduit for operation of the plant at 500 mgd would temporarily diminish the quality of occasional sightseeing and driving for pleasure, now the most common forms of recreation in the area. Once laid, Conduit No. 27, the second parallel conduit, and the access road would cause no further impacts to the recreational resources of the area. The conduits would produce a linear area generally unsuited for further surface construction. This would create an open space that would have potential for limited recreational opportunities.

Flow schedules in the upper South Platte are assumed to remain the same and, therefore, impacts on recreational resources upstream from the proposed project would be concentrated in the river's North Fork up to Roberts Tunnel. These impacts would occur when the plant is operating above the 125 mgd level and would be a result of increased flows from Roberts Tunnel. The specific flows and resulting impacts would depend upon future means of obtaining the additional raw water that would be needed beyond the 125 mgd level. The drawdown on Dillon Resrevoir and the resultant recreational impacts would also depend upon future raw water sources.

LAND USE

If approved, the right-of-way for the dam and reservoir in the South Platte Canyon would be senior rights against any subsequently authorized on public (BLM) and national forest lands. The dam and reservoir would require virtually all of the rights associated with the surface and mineral estate. The action could preclude the granting of any additional use authorizations and would further preclude construction of a water storage or hydroelectric reservoir at this site. In total, the dam and reservoir would commit approximately 38 acres of federal lands to this single, primary use. Of the 38 federal acres that would be in the right-of-way, 31 acres would be disturbed during construction. After project completion, about 25 would be occupied by the dam and reservoir. The proposed project would disrupt present and probable future land uses to varying degrees. Strontia Springs Dam and Reservoir would permanently dedicate 117 acres from present uses to specific use for municipal and industrial water diversion.

Roads would occupy an additional 9 acres of forest and woodland in both the present and future, of which about 7 acres would be federally managed. Another 8 acres (7 federal acres) of forest and woodland would be disturbed by road construction; the disturbance would last for about ten years. Four acres of private land in the Stevens Gulch area would be used for construction purposes for about three years and would require another ten years to regain their original productivity for forest and woodland use. Five acres (about 2 federal acres) of forest and woodland area would be disrupted by powerlines and telephone lines but less than 1 acre would be permanently committed over the life of the project. Tables 1-1 and 1-2 detail the acreages of federal lands that would be directly affected by the project.

The proposed facilities in the South Platte Canyon would restrict traffic to that associated with their construction during a three-year period. This would limit the multiple uses of the canyon to those not associated with public use.

Thirty acres of grazing land around the east portal and staging area would be used for construction purposes for about three years. Construction of the treatment plant facility at the initial 125 mgd capacity would disturb 135 acres for a three-year period. Of this, 65 acres would be permanently occupied by structures and lost to other uses. Security fencing around the facilities would enclose about 255 acres and effectively close them to uses other than open space. Addition of incremental plant units between 1983 and 2001, such as flocculation and sedimentation beds, clear water reservoirs, and sludge drying beds, to attain 500 mgd capacity would eventually occupy

an additional 49 acres within this fenced area, with temporary disturbance of as much as 90 acres. About 65 acres outside the security fence on the west side of the plant would be impractical to use for grazing and would be open space.

This total area of 320 acres would support about ten cows yearlong if continued in use for grazing land as at present. A perimeter fence would enclose DWB's 485 acres at the plant site, permitting continued livestock grazing on 165 acres north of and outside the security fence. This area would support five cows yearlong. Construction of Conduit No. 27 would disturb about 105 acres of grazing land for five years until fully revegetated and about 20 acres of cropland (probably small grains) for not more than one growing season. If the plant complex were expanded to treat 500 mgd, at least one additional large capacity conduit, capable of carrying at least 350 mgd, would be buried alongside Conduit No. 27 within the existing DWB right-of-way, causing temporary surface disturbance of approximately the same acreage that would be involved in placement of the initial conduit, with about the same temporary impacts.

It is probable that without the project, the right-of-way between Colorado Boulevard and County Line Road would be fully developed for moderate density residential use by 1990, assuming the present linear growth rate of 0.1 mile per year continues. Through this section, owing to fairly intense adjacent development, the corridor would be very noticeable. South of County Line Road, it is probable that by 2001, present grazing use would be largely converted to agricultural subdivisions (zero to one dwelling unit per 10 acres) as far as U.S. Highway 85. In this segment, the large amounts of open space planned and the extremely low residential density would allow developmental layout and design to accommodate the right-of-way without creating a noticeable corridor to the casual observer. The remainder of the corridor, to just north of the treatment plant, would probably develop as agricultural subdivisions and for light industrial use. As with the previous segment, the right-of-way would control layout and design efforts; however, it should not be highly noticeable.

Traffic would probably have to be rerouted or at least restricted to half the available roadway during construction of the first and second conduits, creating delays and inconvenience for motorists. The greatest impacts would be felt by users of South Colorado Boulevard and South Holly Street, where Conduit No. 27 and the second parallel conduit would be laid in the street for more than 1 mile each. The impact of construction for the second conduit would be greater, but this is not quantifiable.

The movement of materials and workers during construction and chemicals and workers for operation and maintenance of the proposed Foothills Project would affect the transportation system. Most significant would be the movement of an average of 400 workers per day

to the area during the three years of construction of the 125 mgd plant.

If two persons were to ride in each vehicle to the construction sites, traffic one way would be increased by about 200 vehicles per day for a total daily increase of 400 vehicles for the three-year period. Construction traffic would add an estimated 100 vehicles to the area's highways daily. It is probable that during the first year of construction nearly all worker traffic would funnel onto Colorado State Highway 75 between Wadsworth Boulevard and Kassler. This would increase those average daily traffic volumes from 7,900 vehicles per day to about 8,300 vehicles per day. Beyond the junction with Wadsworth, the traffic would probably spread out into the transportation network, the effects ultimately becoming negligible. The additional traffic during morning and evening rush hours would probably not affect vehicle movement noticeably. Even less noticeable would be the effects of an estimated additional 100 vehicles per day from construction traffic. This traffic would be added during times when normal traffic would be relatively light, therefore offsetting the impacts. In addition, most of this traffic would be from the aggregate source just north of Kassler to the proposed construction sites in the South Platte Canyon and at the treatment plant complex.

Construction increments at the treatment plant for expansion to the 500 mgd and construction of the second conduit would add about fifteen cars per day, traveling one way, to local traffic during the total of seven years, between 1983 to 2001. This impact is considered insignificant.

Operation of the 500 mgd treatment plant would add as many as 70 vehicles per day to the existing traffic volumes, the result of 35 workers traveling to and from the treatment plant site. Delivery of chemicals for operation of the plant would add about 2 to 8 trucks per day to the transportation system.

Future peak-day water demands with Foothills at 500 mgd may, for infrequent periods of short duration during the summer, require bringing water through the Roberts Tunnel at rates up to about 1,000 cfs. Even with the channel modifications, there could be some minor, temporary flooding of hay meadows adjacent to the stream. These floodflows would be of low velocity with little potential for erosive damage to the meadows. Depending upon the time, these floodflows could be beneficial, by providing additional irrigation, or detrimental, as when hay had been cut but not removed.

These potential overland flows, for which DWB would anticipate purchasing easements, would, in effect, zone the property against construction of permanent buildings or similar uses that could not tolerate occasional flooding. This is not considered a significant problem as meadow areas are not generally suitable for permanent

structures and, in the long run, good land use would probably require that they remain in meadow production.

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Following is Table 3-15, which summarizes the environmental impacts of the proposal at 125 and 500 mgd.

TABLE 3-15

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Environmental Element	Impact of 125 mgd	Impact of Expansion From 125 mgd to 500 mgd
Socio-Economic Conditions	Employment and Manpower: an average of 317 people employed per year reducing unemployment of Denver area construction workers by 12.3% during construction period (3 years); 25 workers for operation and maintenance - for at least 75 years - life of project.	Employment and Manpower: expanding plant to 500 mgd, employment would average 160 workers per construction year, reducing unemployment among construction workers by 4.3% over 6-year construction period; 10 additional people needed for operation and maintenance for the life of the project.
	Accidents: 43 accidents/3 year construction period; 20 accidents for vehicles 75-year operating life; 16 accidents hauling trucks.	Accidents: with expansion to 500 mgd, an additional 35 construction accidents and 53 accidents with trucks.
	Income: 125 mgd would add 0.6% to Denver's average personal income; an average of 317 families and/or individuals would increase income in construction phase.	Income: 500 mgd would add less than 0.6% to Denver's average gross personal income; an average of 317 families and/or individuals would increase income in construction phase.
	Municipal and Industrial Water Systems:	Municipal and Industrial Water Systems:
	-125 mgd can meet maximum-day demands through 1988, consuming 286,883 ac-ft annually.	-Additional treatment capacity beyond 125 mgd would be required in 1988 and also additional raw water supplies - 378,530 ac-ft, if no water restrictions imposed, by year 2001
	Community Lifestyles: lifestyles could remain unchanged until 1988.	Community lifestyles: lifestyles could remain unchanged until 2001.

TABLE 3-15 (cont.)

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Environmental Element	Impact of 125 mgd	Impact of Expansion From 125 mgd to 500 mgd
Water Resources	Surface Water: if flows would exceed 4,400 cfs during construction of the dam, an additional 8,040 tons of sediment would be deposited along the South Platte River, an increase of 11.5% over average annual sediment load.	
	Raw water supply of 79,100 ac-ft presently unused would be utilized in 1988.	Additional raw water would be required:
	-Colorado River Watershed: surface water impacts would be same with or without the proposed action (see No Action, Chapter 8).	-Colorado River Watershed: raw water sources would be needed and are arrayed in Chapter 8.
	-South Platte River System: DWB's ability to divert raw water instantaneously would increase from 400 cfs to 595 cfs. Diversion from various points would vary.	-South Platte River System: A maximum instantaneous demand for raw water would increase up to 775 cfs, 580 more than maximum for plant operating 125 mgd, resulting in greater velocity and increased depth. Maximum diversion requirement of 1,175 cfs if Marston and Kassler are also operating at capacity in peak-use periods.
	Water Quality:	Water Quality:
	-Sedimentation: 0.04 ac-ft (75 tons) additional into South Platte annually. During the construction period, inflow quality would determine water quality; turbidity is unquantifiable but would be reduce.	-Sedimentation: same as 125.

TABLE 3-15 (cont.)

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Environmental Element	Impact of 125 mgd	Impact of Expansion From 125 mgd to 500 mgd
Water Resources (cont.)	Colorado River Watershed: salinity impacts would be the same with or without the proposed action (see No Action, Chapter 8).	-Increased diversions would increase salinity downstream.
Aquatic Resources	Construction would remove 1 acre of aquatic habitat in the South Platte River, or 192 lbs. of trout.	There would be no additional onsite aquatic impacts
	Siltation would reduce bottom fauna and suffocate fish to reduce productivity an average 15% annually during 3 years of construction, a total of 1,224 lbs. of fish.	
	An increase from shoreline configuation to reservoir would increase total fish biomass 230% but mainly nongame fish.	
	Inundation of spawning areas in 1.7 miles of stream would increase fishing upstream in fall.	
	One amphibian pond destroyed.	
Geology, Minerals and Topography	Geology, mineral and topographic features would change, but not significantly.	
	Mining would be lost on the 95 acres to be occupied by dam and reservoir, but it is unlikely a minable ore deposit exists.	

TABLE 3-15 (cont.)

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Environmental Element	Impact of 125 mgd	Impact of Expansion From 125 mgd to 500 mgd
Geology, Minerals and Topography (cont.)	Seismic activity might increase by the impoundment of the water; unquantifiable.	
	78% of 70,000 tons of sediment--54,400 tons (21 ac-ft)--would probably be deposited in the reservoir annually.	
	300,000 tons of aggregate would be excavated to construct the dam; no estimate of possible reserves has been made.	
	Access road cuts would be minor except from survey stations 340 + 50 and 354 + 50, where the old railroad bed would be eliminated.	
	At treatment plant, 4,490 lbs. (3 cu. yds) of sludge would be produced daily. This sludge may cover recoverable minerals.	28,500 lbs. of sludge would be produced daily. This greater amount of sludge will cover a larger area (or cover deeper) possible minerals.
Soils	Sedimentation: 28 acres would be disturbed in canyon from road constructions to add 385 tons (0.3 ac-ft) of sediment to river in 10 years.	
	Powerlines and Telephone Lines: 5 acres disturbed; 68.8 tons (1.036 ac-ft) of sediment added in 10 years.	
	Vegetation: clearing above high water line would disturb 30 timbered acres; 88% of sediments (60.5 tons) would deposit in South Platte initially; an additional 75 tons/yr. would be deposited over the 3-year construction period (225 tons total).	

TABLE 3-15 (cont.)

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Environmental Element	Impact of 125 mgd	Impact of Expansion From 125 mgd to 500 mgd
Soils (cont.)	East portal area: 30 acres of disturbance.	
	Construction of Access Road: 11 acres disturbed; 22.5 tons (0.012 ac-ft) of sediment yielded.	
	Portal access, staging area, pond area; yield 100 tons (0.052 ac-ft) of sediment over 7 years.	
	Treatment plant complex: 145 acres disturbed, yield 167.5 tons annually of sediment with 335 tons (0.173 ac-ft) over 3 years. Also disturbed area would produce 935 tons (0.483 ac-ft) of sediment.	Treatment plant complex: additional 90 acres disturbed, producing 70 tons of sediment annually, 140 tons (0.07 ac-ft) over 2 years. Also, disturbed area would produce 1,445 tons of sediment: 95 acres would be disturbed between years 1983 and 2001, yielding 575 tons of sediment; 204 acres of vegetation would be disturbed; by structure.
	Conduits 26 and 27 would disturb 115 acres; 862.5 tons of sediment would be yielded over 5 years.	The second parallel conduit would disturb 105 acres, yielding 787.5 tons of sediment between 1983-2001. These conduits would disturb a total of 210 acres of vegetation, none permanently.
Terrestrial Resources	Vegetation: 136 acres disturbed, 128 permanently lost with 100 large trees; 582 acres temporarily disturbed, with 5 years required to return near-full production in grassland zones and 10 years in montane and riparian zones. Permanent loss of 27 acres of riparian habitat affected by 15 acre gain, a net loss of 12 acres, plus 10 years loss of habitat.	

TABLE 3-15 (cont.)

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Environmental Element	Impact of 125 mgd	Impact of Expansion From 125 mgd to 500 mgd
Terrestrial Resources (cont.)	Wildlife disturbance would be general and adverse in canyon during construction.	An additional 7 years of construction would increase the probability of adverse impacts.
	-Bighorn Sheep: 3-year construction period could result in as much as 50% loss of herd.	
	-Endangered Species: Peregrine falcon. No impact would occur.	
	-Other animal species: It is possible that the construction may have some effect on one golden eagle eyrie. Deer, mountain lion, and bear may possibly leave the canyon during the construction period. Raptors and other birds may be harmed by the possibility of their flying into the powerlines.	
Climate and Air Quality	Air Pollution: fugitive dust and emissions for 30 months construction.	Air pollution: slight, immeasurable increases in dust and emissions from construction of larger plant and additional conduit.
	Accidental spillages (chlorine, ammonia, toxic chemical gases) could occur but are unquantifiable.	More chemicals would be used thus increasing chances of spillages.
Noise	Construction could raise noise to 80-90 dBA 50 feet from the equipment; canyon and foothills now have 32-60 dBA. Blasting would also disturb the wildlife and people living nearby.	No measurable differences can be identified.
	After construction, ambient sound level would be reduced from 60 to 50 dBA.	

TABLE 3-15 (cont.)

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Environmental Element	Impact of 125 mgd	Impact of Expansion From 125 mgd to 500 mgd
Visual Resources	Inundation: radical but not unpleasant change at reservoir; sustained flow at river would reduce visual variety.	See Table 3-14 for summary of visual impacts at year 2001.
	Strontia Springs Dam: radical change to man-made feature from relatively disturbed landscape would produce high contract.	
	Dam Crest Road: linear scar would be produced.	
	Road Widening: high impacts in cut and line.	
	Staging Area: similar to dam.	
	Powerlines and Telephone lines: very prominent linear impacts.	
	Foothills Treatment Plant: radical change from structural but not from landform or vegetative standpoint.	
	Conduit No. 27 not an excessively high visual impact.	Second parallel conduit not an excessively high impact.
Cultural Resources Archaeological Resources	Impact significant because the plains area has potential site density, because archaeological sites are dwindling, and because there is evidence of Paleo-Indian sites, rarest in American archaeology. Damaged or destroyed as yet undiscovered sites would be of high impact.	The additional 90 acres required for the enlarged plant would increase chances of potential impacts.

TABLE 3-15 (cont.)

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Environmental Element	Impact of 125 mgd	Impact of Expansion From 125 mgd to 500 mgd
Historical Resources	-Total loss of sites through the project are tabularized by impact.	
	-Minor secondary impacts are also tabularized by impact.	
Paleontological Resources	204 acres at plant site and conduit excavations could encounter paleontological resources.	
Recreation	Vegetation removal would affect bighorn sheep and other wildlife.	Impact would be in North Fork and Dillon Reservoir, and would depend upon future raw water sources.
	Construction (3 years) would lose 30-60,000 visits.	
	Construction noise and activity could drive animals away, bighorn sheep, bear, deer, mountain lions, and other species that frequent the area.	
	Construction would cause loss of historical recreational viewing.	
	Dam would impose traffic barrier; through bicycle traffic would be severely curtailed.	
	Kayaking would be eliminated.	
	Filling the reservoir would eliminate 1.7 miles of stream fishing.	

TABLE 3-15 (cont.)

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSAL

Environmental Element	Impact of 125 mgd	Impact of Expansion From 125 mgd to 500 mgd
Recreation (cont.)	Recreation atmosphere would change from rushing stream to dam and placid reservoir.	
	Access road would decrease wildlife habitat and aesthetic appearance. Power lines would also detract visually.	
Land Use	117 acres diverted by dam and reservoir to water diversion.	Between 1983-2001, an additional 49 acres would be permanently and 90 acres temporarily disturbed.
	9 acres of road; 8 more acres disturbed for 10 years.	One additional large conduit would create same disturbance as Conduit No. 27.
	5 acres disturbed by powerlines.	
	30 acres of grazing land used for construction for 3 years.	Present grazing land would probably become agricultural subdivisions.
	Treatment plant construction disturb 135 acres for 3 years; 255 acres would be enclosed by security fencing.	70 more vehicles per day and 2-8 trucks would be added.
	65 acres would be open space; 320 acres would support 10 cows annually.	
	Conduit No. 27 and second parallel conduit would disturb 105 acres of grazing land 5 years and 20 acres of cropland 1 year.	
	Density in residential use 0.1 mi/yr linear rate.	
	Rerouting of traffic would cause unquantifiable inconvenience. Traffic of 400 workers/day for 3 years. ADT volume from 7,900 to 8,300 vehicles per day.	

Chapter 4

Mitigation

CHAPTER 4

MITIGATING MEASURES

INTRODUCTION

The mitigating measures analyzed in this chapter are actions which will in some way reduce or eliminate impacts identified in Chapter 3. Each measure is analyzed in relation to a specific component of the proposed action and the nature and degree of its effect is described. The mitigating measures will be required when and if the proposed project is approved.

Mitigating measures are required by governmental agencies with legal jurisdiction and will be monitored and enforced.

Mitigating measures cover the east portal and staging area, the treatment plant complex, Conduit No. 27, and the second conduit parallel to it. In Waterton Canyon all mitigating measures including those proposed by the applicant concerning the U. S. Forest Service, BLM, and other public lands will be included in the right-of-way permits should they be issued. The project components in the canyon include access roads, the Stevens Gulch staging and portal area, the Strontia Springs Dam and Reservoir, and the powerlines and telephone lines. Measures identified relative to these project components will be made conditions of stipulations of the permits and will be enforced jointly by BLM and USFS personnel.

MEASURES

Right-of-Way: Dam, Reservoir, and Tunnel

Bureau of Land Management and U.S. Forest Service

1. BLM and USFS are limiting the clearing of vegetation to the area within the reservoir, which is below 6,010 feet of altitude, in order to decrease erosion associated with the project. This will also reduce turbidity in the South Platte River, benefiting aquatic life to an unquantifiable degree. The DWB will chip most of the vegetative material generated by clearing the reservoir area up to 6,010 feet of

elevation and will dispose of the chips as mulch in the disturbed area above the high water line. This will help reestablish vegetation, hold moisture in the soil, and prevent erosion.

2. The DWB will use mulching to help revegetate disturbed areas, hold soil moisture, and prevent erosion when cleared vegetation is not available for chips.

3. The DWB will strip topsoil from tunnel muck disposal site and the east portal area and stockpile it before construction of the tunnel. After construction is completed, in 3 years, the disturbed areas will be shaped, recovered with topsoil, and revegetated using the same methods referred to in the discussion of the Stevens Gulch staging area (measure 17).

4. The DWB will strip and stockpile topsoil, reshape disturbed areas, recover with topsoil, and seed land around the treatment plant complex to provide a natural appearance on about 80 acres. Of these, 4 acres will be landscaped with lawn, trees, and ornamental shrubs with a fixed irrigation system as proposed in Chapter 1. The remaining 76 acres will be revegetated with native plants and will not have an irrigation system. This measure will mitigate some of the adverse visual impacts of the treatment plant and reduce runoff during construction. Similar measures will be applied to the area as the plant is expanded to 500 mgd.

5. The DWB will stockpile the topsoil, shape disturbed areas, recover with topsoil, and seed 105 acres of disturbed soils along Conduit No. 27. This will establish vegetative cover after construction is completed, reducing sediment yield, impacts on grazing use of the land, and impacts on aesthetic values. The same effects are expected and the same measures will be applied to construction of the second conduit parallel to Conduit No. 27.

6. The DWB will reclaim in a similar manner the area along Conduit No. 26 and the Aurora intertie conduit. Part of this will be reclaimed during the 3-year construction period of the 125 mgd plant. Most of the site, however, will not be reclaimed until after construction is completed. The expansion of the visual impacts of this construction are so closely associated with those of the treatment plant that they are not differentiated.

7. BLM and USFS are requiring that the DWB compensate for the 1.7 miles of free-flowing stream that will be lost to the reservoir. To do this, the DWB will bypass at the Strontia Springs Dam natural flows or 60 cfs of water into the South Platte River from May 15 to September 15. The DWB will bypass natural flows or 30 cfs from September 16 to May 14. Exceptions to this will be allowed during an emergency or during temporary periods involving maintenance or repairs of water facilities or during periods of water shortage.

8. BLM and USFS are requiring the DWB to develop and fund a stream improvement program between the Strontia Springs Dam and Kassler Treatement Plant. This measure is intended as further compensation for the loss of 1.7 miles of stream to the reservoir. The stream improvement program will consist of installation of the necessary log weirs, deflector configurations, braided stream sections, and random rock placements. Detailed examples of such a stream improvement program appear in Appendix 2. This program, developed by the DWB, will be approved by the Colorado Division of Wildlife (DOW), BLM, USFS, and the U. S. Fish and Wildlife Service (USFWS) before implementation. Plans for the program will be submitted for approval by the end of construction and completely implemented no later than 2 years thereafter.

This stream improvement program discussed above will require instream or streamside construction in the form of log or rock weirs, or log or rock deflectors and will require a future Section 404 Permit from the Corps of Engineers before DWB implements this program. At the time of 404 applications, all NEPA requirements will have to be met on whatever impacts would occur as a result of this action.

9. The right-of-way grant would stipulate that public access, use and enjoyment of public lands would be maximized to the fullest extent possible, consistent with project needs and/or compatibility. The BLM and USFS will require that the loss of 30,000 to 60,000 recreation visits to Waterton Canyon during the 3-year construction period be partially compensated for by leaving open to recreationists the upper portion of the canyon, from the upper railroad bridge to South Platte townsite.

To provide for the safety of recreationists and construction personnel, closure of the canyon at the railroad bridge will consist of high security fences and warning signs. The BLM and USFS are responsible for managing public use of the area through development of a land management plan subsequent to the issuance of the grant. See Monitoring section in this chapter.

10. BLM and USFS will require that the DWB build and maintain a replacement public access trail (non-motorized), an estimated 2.5 miles long, to preserve safe public passage around the Strontia Springs Dam and Reservoir. The trail will partially mitigate the loss of 1.7 miles of canyon for recreation by providing visitor access around the dam and reservoir. It will also provide some control of recreational use and reduce littering and trampling in adjacent areas. Location and design of the trail will be subject to approval by BLM and USFS and will be completed coincidently with reopening the canyon to the public. The trail will be built with a minimum width of 4 feet for a walking surface, with grades not to exceed 15 percent, with drainage to minimize the effects of erosion, and with sanitation facilities.

The trail will create new adverse impacts. Building the trail will take about 1 year and will be completed no later than the end of construction. It will disturb about 2 acres. About 1 acre can be reclaimed, requiring 5 years to regain near-normal productivity of vegetation under normal conditions. During that time, about 7.5 tons of sediment will be lost to the reservoir.

11. BLM and USFS will require the DWB to mitigate the adverse effects of construction on known or potential historical, archaeological, and paleontological resources. Methods and techniqes will vary with a number of factors, including the location of the site and its significance.

Specific mitigating measures will be determined site by site. Such measures include the following:

a. Avoidance. This may be accomplished, where feasible, through project redesign.

b. Preservation through recordation. This is most appropriate for sites that would be destroyed whose significance is the information they contain.

(1) Photographic records and measured drawings to Historic American Building Survey standards are required prior to demolition of a property included in or eligible for inclusion in the National Register of Historic Places (E.O. 11593 Sec. 2c).

(2) Surface collection of cultural remains and recording of distribution of artifacts and features may be adequate in some instances.

(3) Major excavation of an affected site according to a specified research design will be necessary when a significant site will be lost or greatly altered.

(4) Salvage excavation is considered a minimal effort. Specific mitigating actions must be developed in consultation with the Colorado State Historic Preservation Officer (SHPO) and the Advisory Council on Historic Preservation in accordance with "Procedures for Protection of Historic and Cultural Properties," (36 CFR Part 800) pursuant to Section 106 of the National Preservation Act of 1966, as amended September 28, 1976 (PL 94-422), and Executive Order 11593.

In order to comply with the provisions of these authorities, an intensive archaeological examination will be necessary for all areas

which will be directly affected by ground-disturbing activities. In addition to this examination, the following requirements must be met:

a. An evaluation of each cultural resource located for eligibility for inclusion in the National Register must be made.

b. In consultation with the SHPO, determination of effects of the proposed action on properties included in or eligible for inclusion in the National Register must be made.

c. Transmittal of findings of effects to the Advisory Council on Historic Preservation for comment with appropriate documentation, including comments of the State Historic Preservation Officer (depending on the type and extent of effects) must be made.

d. Avoidance or mitigation of effects is sometimes necessary. Potential adverse impacts must be evaluated following compliance procedures when an implementation action that threatens any site is proposed.

Excavation at the treatment plant complex and along Conduit No. 27 and the second conduit parallel to it may disturb paleontological resources. This area will be examined for these resources and will also be monitored as described in the Monitoring section later in this chapter.

12. The impacts of the proposed action on historical values in Waterton Canyon were evaluated. The following sites/objects will be specifically mitigated:

Keystone Bridge. This structure, eligible for the National Register, will require no less than a recordation under the Historic American Engineering Record (HAER) by qualified professional engineers and photographers prior to removal.

D&RGW Rockwork. This site/object will be inundated and will be fully recorded via HAER standards prior to destruction.

Concurrence with the State Historic Preservation Officer and the National Advisory Council will be sought after the preparation of a 106/2b statement.

13. BLM and USFS will require all vehicles to be equipped with hand tools (shovel and axe). Two 10-man fire caches will be established, one near the dam site and one at Kassler. BLM and USFS will also require all construction equipment to have approved spark arrestors to reduce the risk of a large man-caused fire.

Right-of-Way: Access Roads

Bureau of Land Management and U. S. Forest Service

14. BLM and USFS will require that all 22-foot wide roads be constructed with the minimum environmental damage possible by utilizing to the maximum extent possible the existing roadway with such additional widening as necessary. The right-of-way width will be limited to 50 feet except at those locations, to be specifically identified in the permit, where 50 feet is insufficient to obtain the 22-foot wide road width.

15. BLM and USFS will require the DWB to use periodic spraying of roads and staging area by water trucks to control dust from wind, vehicles, and equipment, wherever Pentaprime is not used.

16. BLM and USFS will require the DWB to paint all permanent structures and stain all permanent exposed concrete with colors that will be compatible with the surrounding landscape in order to mitigate the impacts on visual resources in the Stevens Gulch staging area.

17. The DWB will use mulching to help revegetate disturbed areas, hold soil moisture, and prevent erosion when cleared vegetation is not available for chips.

18. The DWB will stockpile topsoil, smooth disturbed areas, cover them with the stockpiled topsoil, and revegetate by seeding along roads in Waterton Canyon and at Stevens Gulch staging area. The addition of topsoil and seeding will allow seedlings to become established during the first full growing season. This will reduce sediment loss to the South Platte River, thereby benefiting aquatic life and aesthetic values.

19. Contingent upon granting of the applicant's proposed right-of-way would be DWB's reciprocal agreement to allow unrestricted public access through DWB property to public lands.

Right of Way: Powerlines and Telephone Lines

Bureau of Land Management and U. S. Forest Service

20. BLM and USFS will require that powerlines and telephone lines be constructed according to guidelines from the raptor manual, available upon request from BLM.

The applicant grantee or license shall be governed by 'suggested Practices for Raptor Protection on Powerlines'. Use of this information should be made to design the proposed (fill in name) kV powerline for designated raptor areas with proper grounding, phase spacing and configuration such that it will prevent, to the best of the design engineer's ability, the electrocution of raptors. The applicant shall provide for the grantor, or licensor, drawings which show phase spacings, configurations and grounding practices of the proposed line, and these shall be made a part of the permit.

The use of designs other than those included herein that are, in the opinion of an expert, raptor safe, shall be permitted on public land rights-of-way. The costs for review of such alternate designs shall be at applicant's expense.

The grantor, or licensor, in issuing this permit, hereby assumes its responsibility to inform the applicant, grantee, or licensee of those areas which are designated habitats or potential habitats of raptors or other birds of prey. Any available biological or land management information in meeting the above-stated goal shall be made available to the engineer. (BLM Instruction Memo 76-45).

This measure will save an estimated one raptor annually.

21. BLM and USFS will require powerlines and telephone lines to be located as carefully as possible to minimize disturbance of soil and vegetation during construction and to avoid "skylining," appearance of lines against the horizon when viewed from the roadway. Care in locating utility lines can be the most important element in reducing their visual impact.

22. BLM and USFS will require clearance of vegetation under utility lines to be minimized. In addition, no soil disturbance will be allowed except that necessary to install the poles. Disturbing the vegetative pattern by clearing under a line tends to focus attention of an observer on the disturbed area. This measure will not only reduce the visual impact of utility lines and poles but will also diminish sediment yield and correspondingly reduce impacts on aquatic life.

23. BLM and USFS will require that nonreflective cable be used for all lines and guy wires in Waterton Canyon in order to reduce their

visual impact. Reducing the reflection of sunlight on wires makes them less visible and may endanger low flying airplanes and helicopters, but few aircraft venture low enough in the canyon for this to be considered a significant hazard.

ANALYSIS OF EFFECTIVENESS

Vegetation

The principal effect of clearing vegetation associated with the project is the loss of sediment and adverse visual impacts. The degree to which these effects are felt will vary depending on the nature of the area being disturbed.

According to the proposed action, 117 acres of vegetation would be cleared from the reservoir area, resulting in the loss of 75 tons of sediment annually. Applying mitigating measure 1, only 95 acres would be cleared, only that area below 6,010 feet elevation. This would reduce the sediment lost by 15 tons per year. There would remain a residual sediment loss of 60 tons per year, or 180 tons during the 3-year construction period.

The vegetation cleared from the reservoir area will have to be disposed of. Under mitigating measures 1 and 2 this vegetation will be chipped and used as mulch for disturbed areas around the reservoir area above the highwater line. This will help reestablish vegetation more rapidly, hold moisture in the soil, and ultimately help reduce erosion. The effectiveness of using chipped vegetation is measured in combination with mulching and is discussed below in connection with specific sites.

The 2.5 miles of public access trail that the DWB will build around the Strontia Springs Dam and Reservoir, which is itself mitigating measure 10, will disturb about 2 acres. Of these, about 1 acre could be reclaimed, for which about 5 years would normally be required. During this time, 7.5 tons of sediment would be lost to the reservoir.

If vegetation is cleared under powerlines and poles, about 5 acres would be removed, resulting in the loss of 68.8 tons of sediment and an accompanying but unquantifiable impact on aquatic life. If soil disturbance under powerlines and poles is minimized by mitigating measure 22, the clearing of vegetation only where poles are installed, the disturbance of soil and resulting sediment loss would be reduced to near zero.

Vegetation removed for the construction of access roads in Waterton Canyon will disturb about 28 acres. During the 10 years it would take for the area to revegetate under normal conditions, 385 tons of sediment would be lost to the South Platte River, with an unquantifiable effect on aquatic life. By application of mitigating measure 18, stockpiling topsoil, smoothing disturbed areas, recovering them with topsoil and reseeding, the disturbed area would be restored

in 5 years instead of 10. The total sediment loss would be reduced from 385 tons to 210 tons.

Vegetation removed from Stevens Gulch for the east portal staging area and access road would disturb 11 acres and result in the loss of 122.5 tons of sediment over 7 years for revegetating under normal conditions. Applying mitigating measure 18, revegetating would only require 5 years with a loss of 95 tons of sediment.

Tunnel muck disposal sites will be stripped of topsoil before construction of the tunnel. After construction is completed, the disturbed area will be reshaped and revegetated (mitigating measure 3) employing measures discussed in association with the Stevens Gulch staging area (measure 18). The impact of these disposal sites is minimal and is combined with the staging area impacts.

Vegetation will be cleared from 135 acres at the site of the 125 mgd treatment plant. If allowed to revegetate naturally, there would be a loss of 860 tons of sediment over 7 years. Of the 135 acres disturbed, about 80 acres will remain to be reclaimed after construction of the treatment plant is completed. The DWB will landscape (mitigating measure 4) about 4 of these with lawn, trees, and ornamental shrubs with a fixed irrigation system. About 5 acre-feet of water will be required annually to maintain this area. The remaining 76 acres will be revegetated with native plants and will not have an irrigation system. This area is expected to become established during the first full growing season. The chances of successful seeding in this climatic zone are exceptional; over 70 percent of the precipitation occurs during the growing season. By the planting of seed and replacement of topsoil as in mitigating measure 4, vegetation should be reestablished in about 5 years instead of 7 years under natural conditions. Instead of a sediment loss of 860 tons, there will be a total sediment loss of only 685 tons.

When the plant is expanded to 500 mgd, the total additional disturbance will be 90 acres, requiring a recovery period under normal conditions of 7 years and losing a total of 575 tons of sediment. With the application of mitigating measure 4 as above, the revegetation period would be reduced to 5 years, and a total residual loss would be 453 tons of sediment.

Clearing vegetation in the construction of Conduit No. 27 would disturb 105 acres. Implementing mitigating measure 5, the stockpiling of topsoil, shaping of disturbed areas, recovering and reseeding, would reduce the time of revegetation from 7 years to 5 years and the loss of sediment from a total of 787.5 tons over 7 years to 525.1 tons over 5 years. Adverse impacts on the grazing use of land would be diminished by 50 percent.

The same effects would occur and the same measures would be applied during the construction of the second conduit parallel to Conduit No. 27.

Vegetation cleared along Conduit No. 26 and the Aurora intertie conduit would disturb an area of 10 acres. Applying mitigating measure 6 for revegetation, 3 years would be required instead of 5, under normal conditions, reducing the loss of sediment from 75 tons over 5 years to a total of 50 tons during 3 years. Part of this area will be reclaimed during construction of the 125 mgd treatment plant; most of it will be reclaimed after construction is completed. The expansion of the treatment plant to 500 mgd capacity will not further affect this specific site.

Aquatic Resources

By limiting the clearing of vegetation to within the reservoir area (below 6,010 feet of elevation--mitigating measure 1), sediment loss will be reduced from 75 tons to about 60 tons annually, or 180 tons during the 3-year construction period. This will reduce turbidity in the South Platte River and benefit aquatic life to an unquantifiable degree.

To compensate for the loss of fish production in 1.7 miles of stream when it is inundated by the reservoir, the DWB will apply mitigating measure 7.

In addition, the DWB will develop and fund a stream improvement program between the Strontia Springs Dam and Kassler Treatment Plant (mitigating measure 8). This will consist of necessary log weirs, deflector configurations, braided stream sections, and random rock placements.

This program will increase aquatic life production if the improvements are properly designed and placed. As the aquatic life increases, the fish production will increase and provide additional recreational opportunities in the canyon. Results of a study conducted in Wisconsin indicate achievements that could be expected (Hunt 1971). Figure 4-1 shows the results of habitat development carried out in Lawrence Creek, Wisconsin. This study can easily be applied to the South Platte because of their similarities and lack of dissimilarities. The similarities in the two streams are water qualities (chemical makeup), types of spawning beds, riffle areas, and structure of pools. The water qualities (pH, dissolved O_2, temperature, etc.) are the most important ingredients for a good trout fishery. Trout have a very narrow range of tolerance to these water qualities and reductions to or increases of them would eliminate the trout fishery. The other similarities determine the amount of

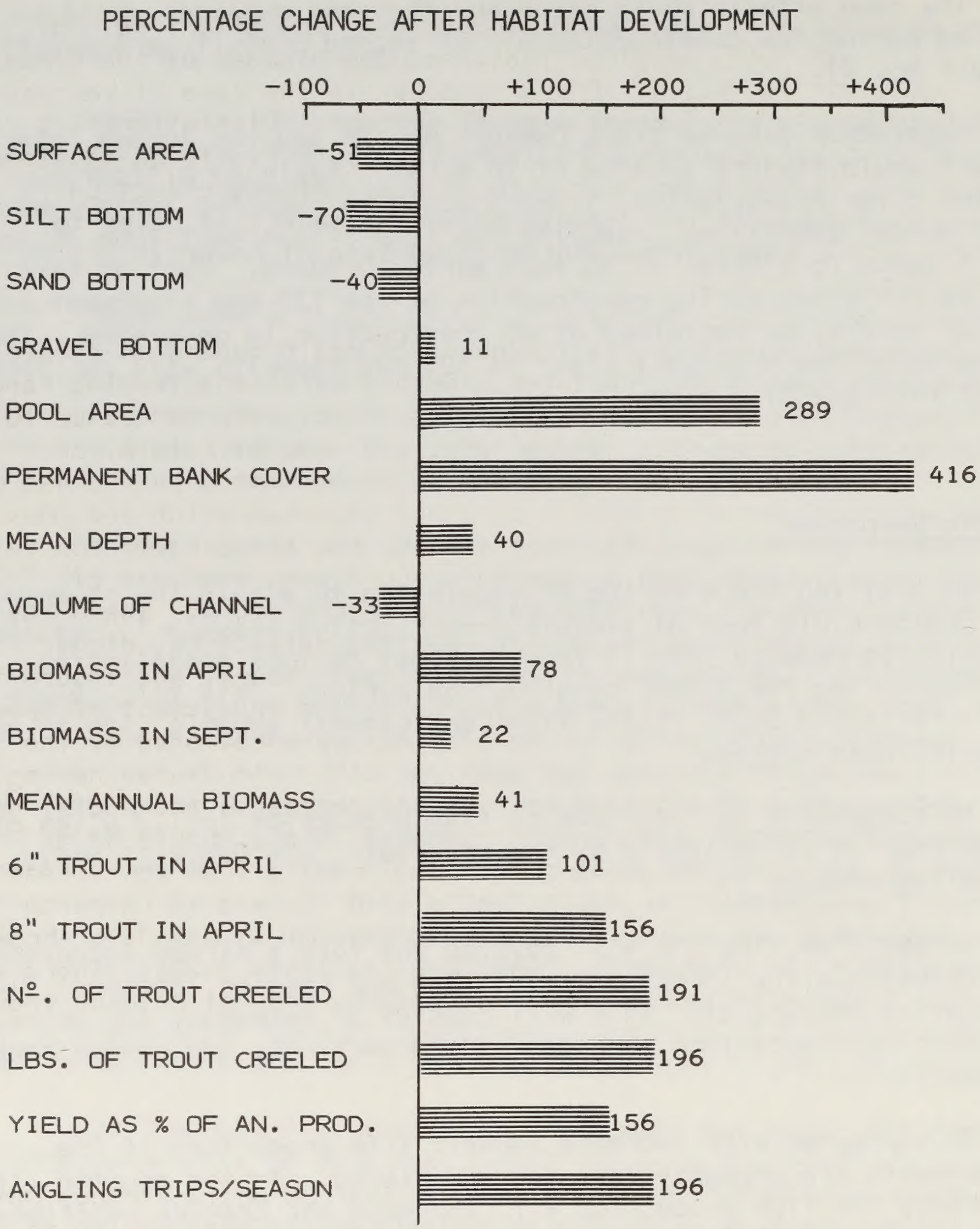


Figure 4-1. Average changes in several physical characteristics, trout population parameters, and the fishery 3 years following completion of habitat development, Lawrence Creek, Wisconsin (Hunt 1971).

production. This is why stream improvements are effective. By manipulation of these physical features, the biomass of the stream can be increased or decreased. Properly done, in the case of Lawrence Creek the biomass was increased by 41 percent. Dissimilarities can be found in types of cover and gradient, the South Platte being steeper. The gradient is not steep enough to have a profound effect on production. Shade is the important part of cover; it helps to maintain proper water temperatures. The type of cover is insignificant.

The effectiveness of the improvements again depend on proper placement and design of structures. Both shelter and feeding ranges can be extended by the creation of pools. Pools can be caused to form by the use of digging logs, deflectors, and dams of natural or artificial materials. Food supplies can be augmented by the use of deflectors which build up a silt bank and weed bed which are good substrata for food organisms. Futhermore, the speeding of the water at the channel end of such a structure could wash the sand of underlying gravel and rubble to help the food picture. Where key fish species are dependent on gravel for spawning deflectors, digger logs, and bank fillers can be used to constrict the channel and insure these gravel beds remain free of sand and silt by the engagement of speeding up the current. Survival of young fish may be encouraged by the installation of stone piles, log jams, or other structures having many interstices. As silt and sand bottoms are decreased and pools, gravel bottoms, and permanent bank cover increased, there should be an increase in biomass. Assuming comparable results from the stream improvement program in the South Platte River as was in Lawrence Creek, Wisconsin, we could expect an increase of 15 pounds of brown trout per acre for Study Area 3 (Map 2-1 and Table 2-20). There would also be a comparable increase in the standing crop of rainbow trout.

Recreation

During the 3-year construction period of Strontia Springs Dam there would be a loss of 30,000 to 60,000 recreational visits to Waterton Canyon. This will be partially mitigated by measure 9, leaving open the upper portion of the canyon from the upper railroad bridge to South Platte. This will allow 4,000 to 8,000 visitors to use the canyon annually. There will be a residual loss of 18,000 to 36,000 visitations over the 3-year construction period.

Loss of recreation visits due to the barrier imposed by the dam will be partially mitigated by 10, the construction and maintenance by the DWB of 2.5 miles of recreation access trail around Strontia Springs Dam and Reservoir. This will allow recreationists to pass through the entire canyon.

Securing DWB's commitment to allow unrestricted access through DWB property to the public lands in Waterton Canyon, plus joint development and implementation of a USFS/BLM comprehensive land management plan for the canyon, would effectively retain all management options to realize maximum public recreation opportunities. However, these measures would not directly affect other project-caused changes in the capabilities of the land, whether these changes or impacts would be adverse or beneficial. See Monitoring section this chapter.

Other recreation impacts which cannot be mitigated are discussed in Chapter 5, Adverse Impacts Which Cannot Be Avoided.

Historical Resources

There is potential destruction of historical sites/objects within Waterton Canyon. These are detailed under the heading Measures and will be mitigated by measure 11, which consists of several standard measures of preserving historical values. These include avoidance, recordation, consultation with the State Historic Preservation Officer and the Advisory Council on Historic Preservation. These are difficult to quantify; in general, historic values will be partially salvaged or totally preserved. These are detailed under measure 12.

Archaeological Resources

Potential destruction of archaeological sites within Waterton Canyon and the South Platte River and treatment plant site will be mitigated by standard procedures detailed for archaeology in measure 11. These include examination of potential sites, evaluation, determination of effects of the project on the site, if any, and consultation with the State Historic Preservation Officer and the Advisory Council on Historic Preservation. Archaeological resources in this area are unknown, and the impact of the project on them is presently unquantifiable.

Paleontological Resources

Potential destruction of paleontological resources within Waterton Canyon and the South Platte River and treatment plant site will be mitigated by standard procedures, detailed under paleontology in measure 11. Excavation at the treatment plant complex and along Conduit No. 27 and the conduit parallel to it is most likely to disturb paleontological resources. This area will be examined for

these resources and will be monitored by a competent vertebrate paleontologist, as described in the Monitoring section later in this chapter. At present, the extent of these resources is unknown, and the impact on them is therefore unquantifiable.

Air Quality

Dust from wind, moving vehicles and equipment in staging areas will reduce air quality in the construction area. Dust will be controlled by mitigating measure 15, the periodic spraying of water to control dust. Some impact will remain, but it is unquantifiable.

Visual Resources

Structures in the Stevens Gulch staging area will be visually incompatible with the surrounding landscape. Applying measure 16, the painting of all permanent structures and the staining of all permanent exposed concrete will mitigate the adverse visual impacts associated with them. This will reduce visual contrast rating from 21 to 17, which is closer to the acceptable contrast limit of 16.

Powerlines and telephone lines will be highly visible from the roadway in Waterton Canyon, producing an effect known as "skylining." This will be mitigated by measure 21, the placing of such lines as carefully as possible to avoid this effect. The difference in visual contrast rating of these lines before and after mitigation cannot be quantified. This is also true of the mitigation of skylining by measure 23, the use of nonreflective cable.

Mitigation of the visual contrast rating for the Stevens Gulch staging area before and after mitigation through revegetation (measure 18) is not quantifiable. Even without mitigation, the disruption of vegetative patterns will produce a visual contrast rating of 10, well within the acceptable limit of 20.

Revegetation of the treatment plant area (measures 4 and 6) will not change the unmitigated visual contrast rating of 27, which is over the acceptable limit of 20. This is unavoidable because the landscaping of 4 acres around the treatment plant site will produce an abnormally green area (in contrast to the general background), which will be as visually disruptive as the site without mitigation.

The mitigation of the visual contrast rating for Conduit No. 27 and the second conduit parallel to it through revegetation (measure 5) is not quantifiable, although the disturbance of vegetative patterns even without mitigation are within acceptable limits. Each conduit

would produce a contrast rating of 10 for vegetative patterns without mitigation. The acceptable limit is 20.

Terrestrial Resources

The killing of raptors on powerlines will be mitigated by measure 20, constructing powerlines and telephones according to guidelines presented in the Raptor Manual, available upon request from BLM. This measure will save an estimated one raptor annually.

Man-caused fires resulting from Foothills would be highest during construction. The number of fires reduced by mitigation would be unquantifiable, but the size of fires should be reduced after mitigation. Correspondingly, impacts on terrestrial resources may not be quantified.

SUMMARY OF ANALYSIS OF EFFECTIVENESS

Following is Table 4-1 which summarizes the impacts, mitigating measures (referred to by number), and the residual impacts discussed in the first two sections of this chapter. The headings correspond in sequence to the categories in Analysis of Effectiveness, immediately preceding.

TABLE 4-1

SUMMARY OF ANALYSIS OF EFFECTIVENESS

Impact	Mitigating Measure	Residual Impact 1/
	VEGETATION	
Sedimentation from clearing of reservoir	(1)	80 percent (180 tons) sediment loss over three-year construction period
Disposal of cleared vegetation from reservoir	(1), (2)	Unquantifiable
Sedimentation resulting from trail building	(10)	80 percent (6 tons) sediment loss over three years recovery time
Sedimentation from clearing for powerlines and poles	(22)	None
Sedimentation from clearing for access roads	(14), (17)	54 percent (210 tons) sediment loss over five years recovery time
Sedimentation from clearing of staging area (Stevens Gulch)	(18)	77 percent (95 tons) sediment loss over five years recovery time
Sedimentation from clearing tunnel muck disposal site	(3), (18)	Combined with staging area impacts
Sedimentation from clearing the treatment plant site (125 mgd)	(4)	80 percent (685 tons) sediment loss over five years recovery time
Sedimentation from clearing the treatment plant site (500 mgd)	(4)	79 percent (453 tons) sediment loss over five years recovery time
Sedimentation from clearing for Conduit No. 27	(5)	67 percent (525.1 tons) sediment loss over five years recovery time

1/ Residual impacts are expressed as percentages of unmitigated impacts and actual residual loss and recovery time.

TABLE 4-1 (cont.)

SUMMARY OF ANALYSIS OF EFFECTIVENESS

Impact	Mitigating Measure	Residual Impact 1/
Sedimentation from clearing for the conduit parallel to Conduit No. 27	(5)	67 percent (525.1 tons) sediment loss over five years recovery time
Sedimentation from clearing for Conduit No. 26 and Aurora intertie conduit	(6)	67 percent (50 tons) sediment loss over three years recovery time
AQUATIC RESOURCES		
Sedimentation from clearing of reservoir	(1)	Unquantifiable
Loss of fish production in 1.7 miles of stream	(7)	Unquantifiable
Loss of fish production downstream of Strontia Springs Dam	(8)	41 percent (15 lbs.) increase in fish production
RECREATION		
Loss of recreation visits due to construction in Waterton Canyon	(9), (19)	18,000 visitations lost. Further quantification is not possible until Resource Management Plan is complete
Loss of recreation visits due to dam induced loss of accessibility	(10), (19)	Unquantifiable
Destruction or removal of historical sites/objects	(11), (12)	Unquantifiable; detatiled qualitatively for specific sites
ARCHAEOLOGICAL RESOURCES		
Destruction of archaeological sites	(11)	Unquantifiable; detatiled qualitatively for specific sites

TABLE 4-1 (cont.)

SUMMARY OF ANALYSIS EFFECTIVENESS

Impact	Mitigating Measure	Residual Impact 1/
	PALEONTOLOGICAL RESOURCES	
Destruction of paleontological paleontological sites	(11)	Unquantifiable; detailed qualitatively for specific sites
	AIR QUALITY	
Dust in staging area	(15)	Unquantifiable
	VISUAL RESOURCES	
Structures in Stevens Gulch staging area	(16)	81 percent (17) visual contrast
Skylining of powerlines	(21), (23)	Unquantifiable
Disruption of vegetative patterns in Stevens Gulch	(17)	Unquantifiable; visual contrast remains at 10
Disruption of vegetative patterns at treatment plant site (125 & 500 mgd)	(4)	Visual contrast remains at 27
Disruption of vegetative patterns along Conduit No. 27	(5)	Unquantifiable; visual contrast remains at 10
Disruption of vegetative patterns along the second conduit parallel to Conduit No. 27 and Conduit 27		Unquantifiable; visual contrast remains at 10
	TERRESTRIAL RESOURCES	
Killing of raptors by powerlines	(20)	None
Fire danger with impacts on terrestrial resources	(13)	Unquantifiable

Water Quality

Requirements relating to preservation of the quality of interstate water are outlined in the Federal Water Pollution Control Act of 1972, as amended. The Colorado Department of Health will monitor water discharged from the dam construction area for pollutants identified in the permit. Water discharged after treatment must not deteriorate water quality in the South Platte River (Table 2-18). This measure also applies to discharge from the Stevens Gulch portal and staging area. According to the Colorado Department of Health, the most probable of the standards identified in Table 2-18 that will be affected are settleable and floating solids, oil and grease, temperature, and dissolved oxygen. A restriction will be imposed on the use of chlorine, a toxic material. In addition, a permit (required by Section 404 of the Federal Water Pollution Control Act (PL 92-500)) will have to be obtained before construction of the dam can begin (see the section on Corps of Engineers, under Description of the Proposed Action, Chapter 1). Under this law, the Strontia Springs Dam is considered fill material discharged into the South Platte River.

Wildlife

Before beginning construction, the DWB will initiate a study to monitor the effects of human activities on the 60-65 head of bighorn sheep during the 3-year construction period in Waterton Canyon. Prior to its initiation, this study plan is to be outlined and approved by BLM and the USFS after consultation with USFWS and DOW. In the event that there are serious adverse impacts on the herd of bighorn sheep in Waterton Canyon, there are two options for action. The herd could be removed from the area and transplanted elsewhere and then brought back after the project is complete. The other possibility is to let the herd survive as well as it can under the existing conditions and replace as much of the herd as was lost.

Geology

Due to the possibility of reservoir-induced seismicity, seismic monitoring devices must be established by the DWB. There will be a minimum of 6 months of preconstruction microearthquake monitoring with one seismometer. If at any time this yields a reasonable indication of local microearthquakes, the network is expanded to a 7 or 8

seismometers capable of accurately locating local events both as to location and depth of hypocenter.

During initial filling of the reservoir, DWB will monitor closely with a full network, as described above, watching carefully for any anomalous increase or localization of events. If such an increase is noted, plans should be in existence to immediately take any action deemed necessary including lowering of the reservoir level.

Archaeology and Paleontology

Onsite examination and monitoring will be carried out by the DWB during ground-disturbing activity for all phases of construction to determine if archaeological and paleontological resources are present and may be identified. A competent archaeologist and vertebrate paleontologist will be used for this monitoring.

Recreation

The Bureau of Land Management and the U. S. Forest Service will jointly develop and implement a comprehensive resource management plan that would include Waterton Canyon. Objectives of the plan would include the following as a minimum:

a. Management of recreation resources will be based on the inherent capabilities of the land itself, both to attract and to support recreation use by activity.

b. Recreation resource management will be further constrained and directed by documented need for recreation by activity, especially in terms of regional supply, demand, and need.

c. Development and implementation of the management plan would also be consistent with DWB project needs as determined jointly by the USFS and BLM in consultation with DWB.

Chapter 5

Unavoidable Adverse Impacts

CHAPTER 5

ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

INTRODUCTION

This chapter presents a discussion of unavoidable adverse impacts which would be caused by construction and operation of the proposed Foothills Project. These include the residual impacts after application of the mitigating measures discussed in the preceding chapter.

SOCIO-ECONOMIC CONDITIONS

During the three years of construction of the first increment of the proposed project (125 million gallons per day) there would be an estimated 43 accidents related to general construction, underground mining, and motorized transport. During construction of the second, third, and fourth increments (125 mgd each), there would be an additional 35 general construction accidents and 53 motorized transport accidents. During the life of the project, about 20 accidents would occur that would involve motor vehicle transports. Chlorine accidents would be expected to occur at a rate of once every 11 years; ammonia accidents would be expected once every 22 years. Although spills of these toxic chemicals are improbable, they would involve possible injuries and adverse temporary impacts on air quality.

An unavoidable adverse socio-economic impact of the project would result from the layoff of 460 construction workers hired during the three-year construction period of the first increment. Assuming that the contract construction unemployed labor force of 3,753 in the Denver-Boulder LMA for March 1977 remains constant (Table 2-1), the impact on this unemployment rate would be to increase it by 12.3 percent. Though the work forces for the second, third, and fourth increments would not be as large as those for the first increment, an average of 160 per construction year or a maximum of 200, there would be unavoidable social and economic impacts to the construction workers and their families from layoffs following completion of each increment. The total effect on the contract construction employment rate would be to increase it by 5.3 percent.

WATER RESOURCES

Surface Water

Discussion presented in Chapter I indicated that when the full Foothills Treatment Plant capacity of 500 mgd is required, additional raw water supplies are also required. The development of such supplies will lead to reduced flows in the respective watersheds from which the waters are obtained and increased flows in the watersheds in which the waters are used. Colorado River basin flows would be reduced, and South Platte River flows would both increase and decrease depending upon the specific reach upstream from Strontia Springs and downstream.

The proposed Strontia Springs Dam would create a new 95-acre lake in place of the existing 1.7 miles of river.

Waters that have been diverted at the existing Platte Canyon and Highline Canal diversion structures by the DWB would be diverted upstream at the Strontia Springs Diversion Dam at rates up to 195 cubic feet per second (cfs). If the Foothills plant at 125 mgd is operated year-round, flows in the South Platte River between Strontia Springs Dam and the Platte Canyon Intake Diversion Dam would average 60,500 acre-feet per year less than the 1964-73 annual average of about 298,000 acre-feet (Table 3-5).

These flows would have adverse impacts on aquatic, aesthetic, and recreation resources.

Water Quality

Although there will be additional diversions from the Colorado River basin using the existing DWB facilities with or without the Foothills Project, diversions would be greater at the 500 mgd capacity. Development of new raw water supply facilities needed for additional diversions from the Colorado River basin would increase salinity concentrations at downstream locations by small amounts. Discussion of the salinity concentration increases is presented in Chapter 8 under Alternative New Sources of Raw Water. The precise amount of increase would depend upon the configuration of the system actually implemented and the actual amounts of water diverted. The reader should also refer to the discussion under Water Quality in Chapter 3.

The water quality of the South Platte River would be affected by the addition of 447.5 tons (0.23 acre-feet) of sediment from the disturbed areas during the three years of construction in Waterton Canyon.

AQUATIC RESOURCE

The proposed 95-acre reservoir would permanently convert 1.7 miles of the South Platte River into a standing body of water. Suitable spawning areas in the 1.7 miles would be lost as the reservoir is filled. The dam and reservoir would destroy one amphibian pond.

There would be an estimated 10 percent reduction in surface area in the 2.6-mile stretch of river between the proposed Strontia Springs Dam and the South Platte Intake. However, with adequate flows, as discussed in Chapter 4, aquatic productivity would increase.

SOILS

Construction of the Foothills Project at 125 mgd would increase soil erosion and sediment yields during the three years of construction and during the first seven years of operation. Table 5-1 summarizes these increases after mitigation. During this ten-year period, about 397.5 tons (0.205 acre-feet) of sediment would flow into the South Platte River; east of the foothills, a total increase of 1,355.1 tons (0.700 acre-feet) would be produced from disturbed areas. Water quality and aquatic habitat would be affected. The loss of 1,752.6 tons (0.905 acre-feet) of soil from 314 acres in the 125 mgd development area would not reduce long-term productivity noticeably. Soil productivity on 95 acres inundated by the dam and reservoir and 76 acres covered by roads, buildings, and major structures would be lost.

Expansion of the Foothills Project to 500 mgd would increase soil erosion and sediment yields between 1983 and 2001. The approximate yield would be 2735.7 tons (1.4 acre-feet) and would not reduce long-term productivity noticeably on the 509 acres impacted.

TABLE 5-1

INCREASED SEDIMENT YIELD IN TONS AFTER MITIGATION

Action	Acres Affected	Present Annual Sediment Yield	Increased Sediment Yield by Year										
			1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	Total
Vegetation clearing	24	15.0	60.0	60.0	60.0								180.0 (0.093 acre-feet)
Reservoir by-pass	1					2.5	2.0	1.5	1.0	0.5	0		7.5 (0.004 acre-feet)
New Trail and road upgrading	28	14.0	70.0	56.0	42.0	28.0	14.0	0					210.0 (0.109 acre-feet)
East portal Access road	3	1.5	7.5	5.0	2.5	0							15.0 (0.008 acre-feet)
Portal access staging and ponds	8	4.0	20.0	20.0	20.0	13.4	6.6	0					80.0 (0.041 acre-feet)
Treatment plant complex Treatment plant site at 125 mgd	135	67.5	167.5	167.5	175.0	116.9	58.1						685.0 (0.354 acre-feet)
Treatment plant site at 500 mgd	90	45.0	112.0	112.0	117.0	78.0	39.0						458.0 (0.229 acre-feet)
Sub-Total at 125 & 500 mgd	225	112.5	279.5	279.5	292.0	194.9	97.1				Sub-Total		1143.0 (0.583 acre-feet)
Conduit No. 26 and Aurora intertie	10	5.0	25.0	16.7	8.3	0							50.0 (0.026 acre-feet)
Conduit No. 27 (350 mgd only)	105	52.5	262.5	175.4	87.2	0							525.1 (0.271 acre-feet)
Second Parallel Conduit	105	52.5	262.5	175.4	87.2	0							525.1 (0.271 acre-feet
											Grand Total		2735.7 (1.4 acre-feet)

GEOLOGY, MINERALS, AND TOPOGRAPHY

Excavation of the dam foundation and abutments would change the existing topography. The excavation would be filled with concrete and the existing natural topography would be replaced by a 243-foot high concrete dam. This change would secondarily affect aesthetics, recreation, and access in Waterton Canyon. The reservoir would inundate geologic, mineral, and topographic features upstream from the dam and below the 6,002-foot spillway elevation. All of the existing features would be lost from view. The geologic features are very similar in much of the Platte Canyon; therefore loss associated with building the dam would not be significant. However, aesthetic values would be affected. Speculative prospecting for uranium or pegmatite mineral deposits on 95 acres within the confines of the proposed reservoir would be impossible during the 75-year life of the proposed project. The sand and clay deposits in the area of the treatment plant would be lost. The value of these deposits is very slight based on current economics.

The Stevens Gulch staging area would require the leveling of four acres of land. Here, the gentle slopes of the natural topographic surface would be flattened; gross changes in topographic elevation would probably be less than 25 feet. At the treatment plant site and at the quarry disposal site excavation, grading and filling would alter the existing land form which would affect aesthetic values.

Construction of the reservoir and ancillary facilities in the Waterton Canyon would destroy 124 acres of vegetation, 108 of which would be permanently lost to production because of inundation, permanent roads, and the reservoir bypass trail (Table 5-2).

The permanent loss of 27 acres of riparian habitat would be partially offset by a gain of 12 acres of riparian vegetation which would naturally establish along portions of the shoreline and 1 acre of riparian vegetation which would reestablish in Stevens Gulch in about five years. A net loss of 14 acres of riparian vegetation would occur. It is possible that mitigation measures applied to riparian vegetative zones would not result in the success indicated; however, it is relatively certain that these areas would regain productivity in five to ten years.

Significant adverse impacts on wildlife species in the entire Platte Canyon could occur from human harassment and illegal killing of wildlife, especially during construction of the dam, tunnel, and roads. The smaller, less mobile species such as rodents and reptiles would be unable to relocate in other areas and would be lost because of the lack of unoccupied niches. Larger, more adaptable species such as deer, sheep, bears, and foxes could probably shift to less intensely-disturbed areas. Loss of wildlife would reduce aesthetic and recreation values. After construction, most species would return to the areas temporarily disturbed and little net loss of biomass would occur.

For three years, noise and other construction associated with the 125 mgd development could drive some bighorn sheep out of the lower sections of the canyon along the stream and could force them to concentrate away from the intense activity. The total impact of all sources could be the loss of the entire 60- to 65-head herd, but it is more probable that the herd would diminish to 30 head, the level reached during the construction of the South Platte Intake. The loss of bighorn sheep would reduce recreation and aesthetic resources in Waterton Canyon, probably affecting 5,000-6,000 recreation visitors to the canyon.

Construction of Conduit No. 27 and the second conduit parallel to it would temporarily disturb 85 acres of grassland vegetation and 20 acres of cropland, bisect two prairie dog colonies and possibly dislodge antelope temporarily from part of 3,000 acres (approximately 8 percent) of their range, north and west of the conduit near the Highlands Ranch (Map 2-7), for a period of about ten months. The impact on these species would be very slight and temporary. The few prairie dog burrows which would actually be excavated

TABLE 5-2

UNAVOIDABLE VEGETATION DISTURBANCE DURING LIFE OF FOOTHILLS PROJECT

Area	Acres Disturbed Permanent	Acres Disturbed Temporary	Temporary Disturbed (Time)	Years Required For Revegetation 1/	Total Acres
Reservoir	95	0	(2 yrs.)	5	95
By-pass trail	2	1	(2 mos.)	5	3
Stevens Gulch Access Road	5	5	(5 mos.)	5	10
Dam Crest Road	2	2	(5 mos.)	5	4
Dam base road	3	-	-	5	3
Road above reservoir	1	1	(5 mos.)	5	2
Concrete aggregate (impervious fill and topsoil)	-	150	(2 yrs.)	5	150
Stevens Gulch portal and staging area	-	4	(2 yrs.)	5	4
East portal	-	30	(2 yrs.)	3	30
Tunnel	-	-	-	-	-
Power & Telephone lines and roads	-	5	(6 mos.)	0	5
Treatment plant complex (non-irrigated 125	65	76	(2 yrs.)	3	141
500	114	90	(2 yrs.)	3	204
Total	179	166			345
Treatment plant complex (irrigated)	-	4	(2 yrs.)	3	4
Conduit No. 27 and 2nd Parallel Conduit (native vegetation) 125	-	85	(3 mos.)	3	85
500	-	85	(3 mos.)	3	85
Total		170			170
Conduit No. 27 and 2nd Parallel Conduit (cropland) 125	-	20	(3 mos.)	1	20
500	-	20	(3 mos.)	1	20
Total		40			40
Sludge disposal		5	(1 yr.)	1	20
Total	287	583			870
SUMMARY BY VEGETATION ZONE					
Riparian zone	14	0		5	14
Montane zone	94	18		5	112
Grassland zone (native)	179	521		3	700
Grassland zone (cropland)	-	40		1	40
Grassland zone (irrigated)	-	4		1	4
Total acreage	287	583			870

1/ When applying reclamation measures to disturbed areas.

(approximately 100) would be less than 0.1 percent of the burrows in the general area.

The risk of a man-caused fire reaching 10 acres would be remote through mitigation. However, the possibility of a large fire always exists.

CLIMATE AND AIR QUALITY

Construction of the plant at 125 mgd and 500 mgd would produce dust and vehicle emissions that would affect the Foothills area. Watering of disturbed areas and use of chemicals to hold down road dust should limit increases in dust in Waterton Canyon to an immeasurable amount. Air quality would not suffer as a result of the operation and maintenance of any part of the proposed project.

Emissions would increase during peak activity in construction (six months each for two consecutive seasons) of the 125 mgd plant and its expansion to 500 mgd. Such increases would not be expected to have a measurable effect on human health or vegetation in the primary impact zone. Increases in fugitive dust owing to construction of the proposed treatment plant complex, Conduit No. 27, and the second parallel conduit are unquantifiable.

An accidental ammonia or chlorine spill would seriously degrade air quality in the vicinity and downwind of the spill. Residents in the area would probably have to be evacuated. The probability of such an accident is quite small, however.

NOISE

Construction within Waterton Canyon would raise noise levels from 32 to 60 decibals, adjusted (dBA), at 50 feet from the equipment. Birds and animals in the canyon and foothills would be adversely affected by the blasting to be done, although this cannot be quantified. Some of this noise would also be audible in the Kassler Treatment Plant area and possibly at Roxborough Park. Although blasting would be periodic and infrequent, it would reach an estimated 105 to 125 dBA at the source (DWB 1974).

After completion of the dam and reservoir, the sound level in the reservoir area would be diminished from 60 to 50 dBA. Water discharge from the dam's regulating valves would cause a continuously loud noise ranging from 85 to 95 dBA near the dam. Estimates are that at 4,000 feet downstream, this sound level would be diminished to 60 dBA. Although this noise would have a significant impact on recreational use immediately adjacent to the dam, the problem would not be significant downstream from Stevens Gulch.

The equipment to be used in construction of both the 125 mgd and 500 mgd facilities is similar to that which would be used in the canyon. The noise levels generated by this machinery range from 85 to 95 dBA at 50 feet. The Roxborough Park community would probably receive levels of about 50 dBA. However, construction noise would vary during the various building periods.

Equipment used in laying Conduit No. 27 and the second parallel conduit would generate noise levels of 80 to 88 dBA. This sound level is considerably higher than existing levels and would create a temporary disturbance in the developed residential areas, but owing to the relatively short time involving any one location and the presence of other similar activities, impacts would not be significant.

As indicated in Chapter 4, few of the anticipated visual impacts of the proposal could be reduced or minimized through practical mitigation efforts. The visual contrasts remaining after mitigation comprise the adverse impacts which cannot be avoided.

Inundation

Inundation in the Waterton Canyon behind the Strontia Springs Dam would radically change the landscape. Instead of a narrow, steep-walled, rocky canyon with the South Platte River dominating the landscape, there would exist a placid lake with steep, rocky hills along its shoreline. The strong sense of enclosure would be relatively unchanged at the west end of the reservoir; this sense would be much weaker near the dam site.

Strontia Springs Dam

This part of the proposed action would impose a massive man-made feature on a relatively undisturbed landscape. As is illustrated by Figure 3-5, the dam would abruptly end the linear continuity of the Waterton Canyon. It would dominate the landscape due to its size and location.

The dam would produce high contrasts with the existing landscape in terms of landform, line, color, and texture, (the four basic elements used by the BLM to determine contrasts between proposals and the existing landscape). Table 5-3 shows the comparison of the physical characteristics between the existing landscape and the proposed dam.

TABLE 5-3

VISUAL COMPARISON OF THE EXISTING LANDSCAPE AND THE PROPOSED STRONTIA SPRINGS DAM IN TERMS OF LANDFORM

Element	Existing	Strontia Springs Dam
Form	Jagged, blocky, enclosed corridor effect is strong	Flat, gently curved, wall-like, abruptly ending the visual corridor
Line	Angular with very strong convergence, broken ridgeline	Vertical and horizontal linear grid on face, horizontal linear top, smooth concavity on face, strong convergence
Color	Dark grey, black, green red-brown	Light gray
Texture	Coarse	Smooth

The contrasts shown in Table 5-3 are evident at Cheesman Dam (Figure 3-6). Although more vegetation is present and the face of Cheesman Dam is stone masonry, the impact would be similar.

Although this structure generates a visual contrast generally considered to be too high by BLM standards, such a structure is both graceful and impressive. However, its construction would still destroy the natural landscape within its view.

Dam Crest Road

This road would not be entirely visible from Waterton Canyon floor or reservoir surface. It would be plainly visible, however, where it enters the visual corridor. At that point it would be a linear, cleared scar traversing a timbered steep slope on a prominent part of the canyon wall (Figure 3-7). Because the road would be above the point of observation, the roadbed itself would not be visible.

Road Widening

Visual impacts of the proposal would be viewed from the existing access road in Waterton Canyon. Because of this, modifications of the existing road that create visual impacts would be very evident and likely to dominate in the foreground. As shown in Figure 3-8, a road with a 22-foot driving surface and associated cut into the rocky canyon wall results in high impacts on the landform in terms of form and color, and moderate impacts on line, created by both the rock and soil cuts and the significantly larger road. The anticipated impacts for the road widening proposals are shown in Table 3-13. An example of the existing road proposed for widening is shown in Figure 3-9 and can be compared with the existing 22-foot standard road (Figure 3-8).

Staging Area

Staining the exposed concrete and painting all other structures a color compatible with the surrounding landscape would significantly reduce the anticipated color contrasts. As shown on Table 5-4, the remaining visual contrast would still be higher than the visual management class maximum contrast limit for that area.

Powerlines and Telephone Lines

Construction of a combined powerline and telephone line to the dam site would generate high visual impacts from the structural standpoint (Table 5-4). This impact would be caused mainly by the imposition of a structure with strong linear characteristics on a landscape that has no such structure presently visible (Figure 3-11).

Foothills Treatment Plant

Construction of the treatment plant would impact the existing landscape, converting a presently undeveloped, sloping tract of land, shown in Figure 2-2, to a partially leveled tract covered with structures, asphalt, and formal landscaping (Figures 1-11).

As indicated on Table 3-12, the visual contrast levels anticipated to occur during construction would be in excess of visual management contrast limits from the structural standpoint, but not excessive in terms of landform or vegetative pattern.

Impacts on landform would mainly be in terms of form. Extensive leveling would occur in the area where buildings would be constructed. However, the present landform is relatively flat with gently rolling terrain, so the contrast is considered moderate rather than high.

TABLE 5-4

ANTICIPATED VIDUAL IMPACTS BEFORE AND AFTER MITIGATION
(Year 2001)

Rated Elements	Anticipated Visual Contrasts before Mitigation			Anticipated Visual Contrasts after Mitigation (Residual)			Visual Mgt Class Maximum Contrast Limit
Limit	Landform	Vegetative Patterns	Structure	Landform	Vegetative Patterns	Structure	Contrast Limit
Inundation	7-13	12	N/A	7-13	12	N/A	16
Strontia Springs Dam	30	N/A	30	26	N/A	26	16
22-Foot Standard Dam Crest & Road	17	20	N/A	17	20	N/A	16
22-Foot Standard Road Widening	25	18	N/A	13	13	N/A	16
Stevens Gulch Staging Area	17	10	21	17	10	17	16
Powerlines and Telephone Lines to Strontia Dam Site	6	7	22	6	7	20	16
Foothills Treatment Plant	12	27	25	12	27	21	20
Conduit No 27	13	10	7	13	10	7	20
2nd Parallel Conduit	13	10	7	13	10	7	20

As shown on Tables 5-4 and 5-5, visual contrasts concerning vegetative patterns would be in excess of visual management class limits. This is due to the addition of shapes foreign to the vegetative patterns: structures, asphalt-covered areas, and formal landscaping. In addition to the shape of the formal landscaping, the grass, shrubbery, and trees are completely out of character for the existing landscape (Figures 1-11 and 2-2), and the contrast would be high since no other formal landscaping is within view and no trees are found on or near the plant site (on the plains physiographic area).

Conduit No. 27 and Second Parallel Conduit

As indicated in Tables 5-4 and 5-5, this part of the proposal would not produce excessively high visual impacts. The area has low sensitivity because there are a number of existing intrusions: the Aurora Conduit and Conduit No. 85, suburbs, railroads and a highway. Because of this, the anticipated impacts of both conduits are relatively small.

TABLE 5-5

ANTICIPATED VISUAL IMPACTS BEFORE AND AFTER MITIGATION
(CONSTRUCTION PHASES)

	Anticipated Visual Contrasts before Mitigation			Anticipated Visual Contrasts after Mitigation (Residual)			Visual Mgt Class Maximum Contrast Limit
Rated Elements							Contrast Limit
Foothills Treatment Plant	23	18	27	23	18	27	24
Conduit No. 27	22	20	18	22	20	18	24
2nd Parallel Conduit	22	20	18	22	20	18	24

CULTURAL RESOURCES

Archaeological Resources

Construction of the treatment plant complex could have extensive impact on archaeological resources. The lithic material noted as occurring generally over the plant site area and buried or undiscovered sites would be destroyed, removed or scattered. Impacts on both known and as yet undiscovered archaeological resources could be of major significance.

Historical Resources

Several sites/objects within Waterton Canyon would be lost. Keystone Bridge might be damaged by removal. Also lost would be 5.5 miles of heavily modified DSP&P railbed to the dam site, about 1.7 miles of Denver and Rio Grande Railroad rockwork on the north side of the canyon, the Deansbury Station and Strontia Springs sites/objects, the telegraph poles in the floodpool area and the modern railroad bridge above Deansbury Station site/object.

The loss of these sites/objects can be minimally mitigated through a general program of recordation (HABS and HAER 1977) prior to destruction and/or removal. However, an opportunity for future study would be lost because the physical remains would be totally destroyed.

Paleontological Resources

Excavations at the treatment plant complex, and along Conduit No. 27 and the second parallel conduit could encounter and disturb common fossils and other materials of paleontological interest as well as unknown or buried archaeological and historical sites.

The destruction or removal of historical, archaeological, or paleontological resources would affect recreation, aesthetic, and scientific values.

RECREATION RESOURCES

Closure of the canyon downstream of the reservoir area for three years would result in a loss of at least 18,000-36,000 high-quality recreation visits. These losses would probably be absorbed by other recreational resources along the eastern foothills of the Front Range.

Construction of the dam and the reservoir would alter or permanently destroy many of the unique and impressive natural recreational characteristics in Waterton Canyon. Habitat for wildlife would be lost, and decreases in the numbers and species, especially bighorn sheep, would occur. The quality of any subsequent recreational experiences would then be decreased to the degree this wildlife did not return to the area after the completion of construction. After construction, most species would return to the areas temporarily disturbed.

Opportunities for through-bicycling would be severely curtailed as would the ability to kayak the South Platte in Waterton Canyon.

Building the dam and reservoir and upgrading roads would bring about the loss of the remnant features of the narrow gage railroad and end any future consideration of it for tourism and recreational purposes.

High-quality trout fishing opportunities would be eliminated on 1.7 miles of stream.

Strontia Springs would be a terminal storage reservoir and it is probable that no boating, fishing, or swimming would be allowed. The steep terrain surrounding the reservoir would prevent most other uses except hiking. Loss of this area to most recreational uses may result in a decline in the total number of vistitors to the canyon. However, since the lower canyon below the dam is capable of supporting additional use, there may be more intensive use of this area without a significant loss in the total number of visitors. Any resultant loss of recreation visitors cannot be quantified.

At least initially, the dam and reservoir may attract a large number of people to the area, thus decreasing opportunities for solitude, increasing littering and trampling of the resource, and possibly driving out those species of wildlife that cannot abide frequent contact with humans.

The quality of recreational experiences in the future Roxborough State Park and of occasional sightseeing and driving for pleasure may decrease somewhat with the coming of greater numbers of people, traffic, and noises associated with construction at the treatment

plant area. As other intensive developments encroach on the area in the future, the impact from the treatment plant would diminish.

Impacts on recreational resources upstream from the proposed project will be concentrated in the river's North Fork up to Roberts Tunnel. These impacts would occur when the plant is operating above the 125 mgd level and would be a result of increased flows from Roberts Tunnel. The specific flows and resulting impacts will depend upon future means of obtaining the additional raw water that will be needed beyond the 125 mgd level. The drawdown on Dillon Reservoir and the resultant recreation impacts will also depend upon future raw water sources.

LAND USE

If approved, the right-of-way for the dam and reservoir and roads in Waterton Canyon would be senior rights against any subsequent applications for use authorizations on public (BLM) and national forest lands. The dam and reservoir would commit more than 38 acres of federal lands to this single, primary use.

Construction and operation of the proposed Strontia Springs Dam and Reservoir would permanently convert 117 acres (below maximum pool level) from present and future forest and woodland use to a municipal and industrial water diversion use. In addition, roads would occupy an additional 9 acres of forest and woodland in both the present and future. Another 8 acres of forest and woodland would be disturbed by road construction; the disturbance would last for about five years. Four acres in the Stevens Gulch area would be used for construction purposes for about three years and would take another five years to regain their original productivity for forest and woodland use.

The proposed facilities in Waterton Canyon would restrict traffic downstream from the dam and reservoir area to that associated with construction during a three-year period, limiting the multiple uses of that portion of Waterton Canyon.

Thirty acres of grazing land around the east portal and staging area would be used for construction of the 125 mgd plant for about three years. One animal unit would be lost each year.

Construction of the treatment plant facility at the initial 125 mgd capacity would disturb 135 acres for a three-year period. Of this, 65 acres would be permanently occupied by structures and lost to other uses. Security fencing around the facilities would enclose about 255 acres, effectively closing them to uses other than open space. Incremental addition of plant units such as flocculation and sedimentation beds, clear water reservoirs and sludge drying beds to attain 500 mgd capacity between 1983 and 2001 would eventually occupy an additional 49 acres within this fenced area, with temporary disturbance of as much as 90 acres. About 65 acres outside the security fence on the west side of the plant would be impractical to use for grazing and would remain as open space. About 320 acres which would have supported 10 cows would be lost to grazing.

Construction of Conduit No. 27 would disturb about 105 acres of grazing land for three years until fully revegetated and would disturb about 20 acres of cropland (probably small grains) for not more than one growing season. When the plant complex is expanded to treat 500 mgd, at least one additional large-capacity conduit, capable of carrying at least 350 mgd, would be buried alongside Conduit No. 27

within the existing DWB right-of-way, causing temporary surface disturbance of approximately the same 105 acres that would be involved in placement of the initial conduit, with about the same temporary impacts.

The vehicle traffic affected would be rerouted or at least restricted to half the available roadway. The greatest inconvenience would be to users of South Colorado Boulevard and South Holly Street, where Conduit No. 27 and the second parallel conduit would be laid in the street for more than 1 mile each. The impact of construction for the second conduit would be greater, but it is not quantifiable.

During 125 mgd project construction, daily traffic volumes would be increased from 7,900 vehicles per day to 8,300 vehicles per day on Colorado State Highway 75 between Wadsworth Boulevard and Kassler. The slight increase would not be noticeable.

Expansion to 500 mgd capacity and construction of the second conduit would add about 15 cars per day one way to local traffic for seven years, between 1983 and 2001. This impact is considered to be insignificant.

SUMMARY OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Following is a summary table of adverse impacts which cannot be avoided (Table 5-6).

TABLE 5-6

SUMMARY TABLE OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Environmental Element	Impacts at 125 mgd	Impacts of Expansion From 125 mgd to 500 mgd
Socio-Economic	Accidents: 43 during 3 years of construction.	Accidents: 35 general construction accidents and 53 motorized transport accidents during construction of additional increments; 20 motor vehicle accidents during life of project; chlorine accidents 1 each 11 years; ammonia accidents 1 each 22 years.
	Employment and Manpower: layoff of 460 construction workers after 3 years.	Employment and Manpower: layoff of undetermined number of construction workers after each completed increment. The maximum number of workers laid off will be 200.
Water Resources	Surface Water	
	-Strontia Springs Dam would create a new 95-acre reservoir in place of 1.7 miles of river.	
	Water Quality	
	-Salinity would increase with or without the proposed action.	Increased diversions would further increase salinity through decreased flows in the Colorado River
	-447 tons (0.23 ac-ft) of sedimentation would be added to South Platte River during 3 construction years.	

TABLE 5-6 (cont.)

SUMMARY TABLE OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Environmental Element	Impacts at 125 mgd	Impacts of Expansion From 125 mgd to 500 mgd
Aquatic Resources	1.7 miles of South Platte River would be converted into 1.7 miles of reservoir, suitable spawning areas will be lost, plus 1 amphibian pond.	Increased flows would cause unquantifiable bank erosion and loss of 20 miles of riparian vegetation which would result in unquantifiable aquatic and terrestrial habitat loss and reduce fish crop.
	10% reduction in surface area in 2.6 miles between Strontia Springs Dam and South Platte Intake; however, aquatic productivity would increase with adequate flows.	Impacts resulting from increased diversions cannot be identified, as the needed new water sources are not known.
Soils	Soil erosion and sediment yields would increase in 3 years construction and 7 years of operation; 397.5 tons (0.205 ac-ft) of sediment into Platte River and 1.355 tons (0.700 ac-ft) from disturbed areas eastward.	Soil erosion and sediment yields would increase between 1983-2001 approximately 2,735.7 tons (1.4 ac-ft) and would not noticeably reduce productivity long-term on 509 acres impacted.
	314 acres of soil (1,743 tons) would not reduce long-term productivity; 95 acres inundated and 76 acres covered by construction would lose productivity.	
Geology, Minerals, and Topography	Concrete dam and excavation would change topography.	No significant differences from 125 mgd.
	Reservoir would inundate upstream and below the 6,002 foot spillway.	
	Speculative prospecting on 95 acres of the reservoir would be lost.	

TABLE 5-6 (cont.)

SUMMARY TABLE OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Environmental Element	Impacts of 125 mgd	Impacts of Expansion From 125 mgd to 500 mgd
Geology, Minerals, and Topography (cont.)	Sand and clay deposits would be lost.	No significant differences from 125 mgd.
	78% (54,400 tons) of sediment from the river would be deposited in the reservoir annually.	
	4 acres would be leveled for Stevens Gulch staging area.	
Terrestrial Resources	Vegetation: 108 of 124 disturbed acres would be lost by construction. 14 acres of riparian vegetation would be lost.	
	Wildlife: harassment, illegal killing, noise would all disturb wildlife, and some would be lost (unquantifiable); some would return after construction is complete.	The additional 7 years of construction would increase the probability of impacts on wildlife.
	-Bighorn sheep: Probably 50% reduction from construction to 30-35 head, affecting 5,000-6,000 recreation visitors to the canyon.	
	-Deer, mountain lions, foxes and bears may shift to less intensely disturbed areas.	

TABLE 5-6 (cont.)

SUMMARY TABLE OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Environmental Element	Impacts at 125 mgd	Impacts of Expansion From 125 mgd to 500 mgd
Terrestrial Resources (cont.)	Conduit construction would disturb 85 acres of grassland vegetation, 20 acres of cropland, bisect 2 prairie dog colonies and dislodge antelope temporarily from 8% of their 3,000 acres range for 10 months. These impacts are not significant.	
	Man-caused fires from Foothills would be highest during construction. The number of fires reduced by mitigation would be unquantifiable, but the size of fire should be reduced after mitigation.	
Climate and Air Quality	Dust and vehicle emissions resulting from Foothills would be highest during construction but are unquantifiable after mitigation of watering.	Dust and vehicle emissions resulting from Foothills would be highest during construction but are unquantifiable after mitigation of watering.
	Ammonia or chlorine spills are unlikely but would degrade air quality if they occurred.	Spills would be more likely as chemicals would be handled more frequently.
Noise	Construction would raise noise from 32-60 dBA and adversely affect wildlife and people. After construction the sound level would be reduced from 60 to 50 dBA. Construction equipment can range from 80-95 dBA at 50 feet away; however, sound level would lower after construction.	No measurable differences can be identified; construction (at a reduced level) would continue for 7 years longer.

TABLE 5-6 (cont.)

SUMMARY TABLE OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Environmental Element	Impacts at 125 mgd	Impacts of Expansion From 125 mgd to 500 mgd
Visual Resources	Inundation would change the Waterton Canyon from a canyon to a placid lake; then radical change would not be displeasing.	Visual contrasts resulting from elements of the 125 mgd construction would be reduced only to the extent that disturbed areas would have been revegetated. Visual contrasts resulting from construction of additional increments would be less than those from construction of the 125 mgd facility. This would be the result of the features of the 125 mgd facility being a part of the landscape at the time of the additional construction.
	According to BLM's Visual Management Classification, construction elements would present the greatest contrast to the existing environment (Tables 5-4 and 5-5)	
	Strontia Springs Dam would impose a man-made feature on a relatively undisturbed landform, not an adverse impact to those who enjoy viewing dams.	
	The dam Crest Road would be a visible linear scar.	
	Road widening would result in high impact in form and color.	

TABLE 5-6 (cont.)

SUMMARY TABLE OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Environmental Element	Impacts at 125 mgd	Impacts of Expansion From 125 mgd to 500 mgd
Visual Resources (cont.)	The staging area would result in high impact from a color standpoint. The Foothills Treatment Plant would highly impact the landscape in excess of visual management contrast limits from a structural as well as vegetative standpoint.	
Cultural Resources Archaeological Resources	Construction would bury, destroy, or remove both known and unknown archaeological resources.	Construction would bury, destroy, or remove both known and unknown archaeological resources on an additional 90 acres.
Historical Resources	The following sites would be lost or removed: Kenstone Bridge, 5.5 miles of DSP&PRR roadbed, 1.7 miles of D&RGRR rockwork, Deansbury Station and Strontia Springs site, telegraph poles in the floodpool, and the modern railroad bridge. Any opportunity for future study would be lost.	The following sites would be lost or removed: Keystone Bridge, 5.5 miles of DSP&PRR roadbed, 1.7 miles of D&RGRR rockwork, Deansbury Station and Strontia Springs site, telegraph poles in the floodpool, and the modern railroad bridge. Any opportunity for future study would be lost.
Paleontalogical Resources	Excavations could encounter and disturb paleontological resources.	Excavations could encounter and disturb paleontological resources.

TABLE 5-6 (cont.)

SUMMARY TABLE OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Environmental Element	Impacts at 125 mgd	Impacts of Expansion From 125 mgd to 500 mgd
Recreation	18,000-36,000 recreation visits would be lost during construction.	Impacts on North Fork and Dillon Reservoir will depend upon future raw water sources.
	Alteration or permanent destruction of many of the unique and impressive natural recreation characteristics of Waterton Canyon.	
	Habitat for wildlife and numbers of wildlife would decrease, thus reducing viewing opportunities.	
	The remains of the railroad bed for DSP&PRR would be lost.	
	Through bicycling and kayaking would be severely curtailed.	
	1.7 miles of stream trout fishing would be lost.	
	The dam may attract visitors (and increase litter).	
	People, traffic, and noise would reduce recreation quality of Roxborough Park.	
Land Use	117 acres would convert from forest to water diversion use.	Additional incremental plant units would occupy an additional 49 acres with 90 acres temporarily disturbed; 65 acres would remain as open space; 320 acres would be lost to grazing.
	Road would disturb 17 acres; 9 acres would be permanently occupied by roads.	

TABLE 5-6 (cont.)

SUMMARY TABLE OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Environmental Element	Impacts at 125 mgd	Impacts of Expansion From 125 mgd to 500 mgd
Land Use (cont.)	4 acres in Stevens Gulch would be disturbed for 3 years and would take 5 years to recover.	Construction of Conduit No. 27 would disturb 105 acres of grazing land for 3 years. The same acres would be disturbed when the additional parallel conduit is built.
	30 acres of grazing land would be used for construction.	15 cars would be added per day between 1983 and 2001
	135 acres would be disturbed for 3 years of construction, and 65 acres would be lost to structures.	
	Security fencing would enclose 255 acres.	
	Vehicle traffic would be restricted in construction area. Volume of traffic would increase from 7,900 to 8,300 vehicles per day on Highway 75.	

Chapter 6

Relationship Between Local Short-Term Uses of Man's Environment and Maintenance and Enhancement of Long-Term Productivity

CHAPTER 6

THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

This chapter discusses productivity of the environment which would be affected by the construction and operation of the proposed Foothills Project. In this context, "short term" refers to the three years required to construct the components of the Foothills Project at 125 mgd and the three additional two-year construction periods necessary to bring the treatment plant to 500 mgd. "Long term" refers to the estimated 75-year project life. Beyond 75 years, the dam and reservoir would probably continue to affect productivity, since the removal of this structure would not be practical. It is assumed that other aboveground, permanent facilities would be removed and partially salvaged and the affected areas reclaimed.

In total, about 580 acres of land in a naturally productive state would be disturbed during construction of the 125 mgd plant, of which 76 acres would be occupied by man-made buildings, roads, trails, and structures, and 95 acres of aquatic and terrestrial habitat would be transformed from stream to reservoir habitat. Uses on the remaining 409 acres would be modified temporarily or disturbed by short-term construction-related activities. An additional 309 acres would be disturbed during expansion to 500 mgd capacity.

The short-term uses on the 383 acres would reduce natural productivity during construction and a three- to five-year restoration period. During this time about 447 tons of vegetation would be lost. Long-term annual production thereafter would be unaffected. The occupation of 76 acres by structures would eliminate natural productivity; a long-term net loss of biomass during the 125 mgd construction phase and in the 500 mgd construction phase is not quantifiable.

Filling of the proposed reservoir would inundate 95 acres of terrestrial habitat and replace it with a relatively sterile aquatic habitat. Terrestrial biomass estimated at 4,000 tons would be lost during the 75-year project life, and since it would remain afterwards, the dam would continue to reduce biotic production at about 42 tons annually thereafter. The short-term construction uses in Waterton Canyon would affect long-term land uses on 117 acres (to high water line) by eliminating most land use options in the future. However, casual lana uses, such as recreational and wildlife, would continue. Of the 117 acres, 38 acres would be federally managed, and multiple uses would be restricted to uses associated or compatible with the primary purpose of water diversion.

The removal of vegetation and associated soil disturbances would increase sediment yield by 1,752.6 tons in the short-term construction and restoration period. As vegetation became reestablished, sediment production would stabilize at a near natural level. During the construction and restoration period, 397.5 tons of the additional sediments would be added to a 2.6-mile stretch of the South Platte River. The loss of about 35 head of bighorn sheep would be associated with construction in Waterton Canyon. In the long term, the herd would regain its present level of 60-65 head, and production would return to present levels.

Human interest values would be significantly impacted in both the short term and long term. Closure of Waterton Canyon to public use during the three years of construction would eliminate 18,000 to 36,000 vists for recreational use and aesthetic enjoyment. Over the long term and beyond, although the canyon would be reopened to public use, the use would be changed from those opportunities associated with an essentially free-flowing stream in a rugged, relatively undeveloped setting, to those associated with a setting dominated by the dam, reservoir, and other man-made facilities.

The local short-term use of the project areas would entail disturbance within the area of the old DSP&P right-of-way and the old Denver and Rio Grande rockwork roadbed above the dam site.

East of the Foothills Project site, there would be a loss of opportunities to study undiscovered archaeological sites and paleontological resources. Although these cultural resources would be identified and recorded during construction, the options for future interpretation and study would be lost.

The landscape resulting from the proposal would be permanently altered. It would display more intrusions than at present and would thus affect those who view it. The degree of scenic degradation would vary with the location of the viewer and would be directly related to the unavoidable impacts indicated on Table 5-4.

Although silt would be added during the short-term construction period, the proposed dam would trap 2,110 acre-feet of silt over the 75-year project life and reduce turbidity in 2.6 miles of the South Platte River below that point. This probable improvement in aquatic habitat would be more than offset by the reduction in flows in that area. Trout production would be reduced by 10 percent, or 95 pounds annually, for a total loss of 7,125 pounds of trout during the long-term (75-year) life of the project.

In the short term, grazing use would be affected by construction on 350 acres, and dry farm production would be affected on 20 acres. In the long term, future land use on 610 acres would be affected. Of the 610 acres, 485 acres at the proposed treatment plant complex are

presently grazing lands. At 125 mgd capacity, 65 acres would be occupied by structures. Security fencing around the facilities would enclose about 225 acres. Incremental addition of plant units to attain 500 mgd treatment capacity would eventually occupy an additional 50 acres. About 65 acres outside the security fence on the west side of the plant would be impractical to use for grazing and would be open space.

The Denver Water Board (DWB) would expect to continue to lease about 165 acres of their lands for livestock grazing. This 165 acres is located north of and outside of the security fence. In the long term, 105 acres of land within the DWB's existing right-of-way for proposed Conduit No. 27 and the second conduit parallel to it would be lost from possible development for residential use.

During the short-term construction period, the Foothills Project would use about 28.9 million kilowatts of electrical energy. In the long term, however, the hydrogenerator would produce 11 million kilowatts annually at 125 mgd and 28 million kilowatts at 500 mgd. The plant and dam operation would use 8 million kilowatts annually at 125 mgd and 12 million kilowatts at 500 mgd.

Assuming that the unemployment level among transportation and public utilities workers remains stable, the permanent work force needed to maintain the entire proposed project would reduce the unemployed transportation and public utilities labor force of 649 (Table 2-1) in the DBLMA by 5.4 percent, thus maintaining and enhancing the long-term productivity of 35 families.

Chapter 7

Irreversible and Irretrievable Commitments of Resources

CHAPTER 7

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

This chapter identifies the extent to which the proposed action would irreversibly diminish the range of potential uses of the land and its resources. In this context the term irreversible is defined as use that is incapable of being reversed; once initiated, it would continue. The term irretrievable means irrecoverable; once used, it would not be replaceable.

Although the natural productive capacity of impacted land and water resources would be regained in the short term or long term, or after the 75-year project life, interim production would be lost. Those production losses cited in Chapter 6 would be irretrievable.

The Denver Water Board (DWB) has constructed and is operating facilities which can provide a reliable raw water supply to Waterton Canyon of 206,000 acre-feet per year after losses. The commitment to use this water has been made, and construction of the Foothills Project at 125 mgd does nothing to modify that commitment. The expansion of the proposed Foothills Treatment Plant from 125 mgd to a capacity of 500 mgd to meet the max-day demands of the projected population would be concurrent with the development of additional sources of raw water to satisfy the annual demand of that population.

When and if such expansion occurs, additional water resources, whether they originate in the Colorado River Basin or the South Platte River Basin, would be committed to use by users within the DWB service area.

Construction of the Foothills Project would require 450,000 tons of aggregate, 73,000 tons of cement, and 19,000 tons of steel. Except for possibly 5,000 tons of steel which could be practically salvaged, these resources would not be recovered and would be considered irretrievable.

The visual impacts identified as unavoidable in Chapter 5 constitue irreversible and irretrievable commitments of resources. From the practical standpoint, even if the entire project were abandoned some time after construction, it would be nearly impossible to return the dam and reservoir area, all constructed roads, the staging area, Conduit No. 27, and the second parallel conduit to a natural or quasi-natural state.

The dam and reservoir in Waterton Canyon would irreversibly change the 95 acres of aquatic and terrestrial habitat into reservoir

habitat. Associated with the construction of the facilities could be the loss of 35 bighorn sheep. The 18,000-36,000 recreation visits to the canyon would be irretrievably lost during construction. The present unique and impressive natural recreational characteristics in the canyon would be irretrievably lost; the ability to bicycle or kayak through the canyon would probably be lost.

Recreational use patterns and trends would be altered, and land use options not compatible with the dam's presence would be eliminated. Considering present technology, this structure could not be practically removed; these effects, therefore, could not be reversed at any time in the foreseeable future.

The construction of the proposed project would cause all known or unknown archaeological, historical, and paleontological resources to be preserved only as data destroyed or removed from context. Although there may be other similar cultural sites and values at other locations, the loss of these particular resources would be considered an irretrievable commitment.

Those sites within the Waterton Canyon above the dam site would continue to be irreversibly and irretrievably commited as total losses. These sites include the DSP&P Railbed, the Deansbury Station site, the Deansbury Bridge, and the D&RG Railbed above the dam site. Below the dam, the Keystone Bridge would be removed through the radical change of the canyon environment and massive modifications in the area.

There would be a good chance that buried archaeological and/or paleontological resources would be destroyed and lost at the treatment plant complex and along Conduit No. 27 and the second parallel conduit; this commitment would be irretrievable.

The 65 acres which would be occupied by permanent structures at the treatment plant would lose their natural productivity for the life of the project, as would an additional 49 acres that would eventually be occupied by increments to attain the 500 mgd plant capacity. The right-of-way for Conduit No. 27 and the second parallel conduit, along the Aurora's adjoining right-of-way, would control future land uses. During the 75-year project life, the right-of-way would result in residential or similar layout and design development in adjoining areas to accommodate the restrictions against permanent structures within the right-of-way.

These developments would remain long after the life of the project, as would their layout and design features. It would be possible for adjoining uses to extend onto the right-of-way after 75 years; however, the adjoining developments would still control layout and design over the conduits. The developmental layouts and design would be irreversible.

A commitment of electrical energy would be associated with the construction and operation of the proposal. Construction would require about 28.9 million kilowatts. Eight million kilowatts annually, or a total of 600 million kilowatts, would be used over the 75-year project life. This represents a total commitment of 628.9 million kilowatts of electrical energy. However, since electrical energy would not be produced without the project, only 28.9 million kilowatts lost to construction would be irretrievable.

In summary, there would be a commitment of $134,000,000 in goods, services, and manpower over a three-year period for construction of the first increment of the proposed project. To complete the second, third, and fourth increments would require commitment of an additional $131,084,000--$54,680,000 in 1978 (compounded with an escalation factor of 8 percent)--in physical and human resources by 2001.

Chapter 8

Alternatives to the Proposed Action

CHAPTER 8

ALTERNATIVES TO THE PROPOSED ACTION

INTRODUCTION

Two categories of alternatives were considered: (1) major alternatives, which include options for no action and changes in structure and location, and (2) minor alternatives, which pertain to options regarding a single component of the project.

The alternatives are described and analyzed under the assumption that appropriate mitigating measures proposed in Chapter 4 would be applied to each alternative. Mitigated impacts of each alternative are described to the extent that the option differs from the proposed action. Table 8-1 compares impacts of the proposed action and the major alternatives.

Besides the alternatives analyzed, numerous other alternatives were considered but were rejected because they were not technically feasible or they would result in unacceptable environmental impacts.

In addition, an analysis is presented on alternatives for potential raw water sources. Although these are not a part of the proposed Foothills Project and are not discussed elsewhere in the statement, they are appropriate to be included, because existing reliable water sources would be fully utilized during the life of the project.

TABLE 8-1

COMPARISON OF IMPACTS OF THE PROPOSAL AND MAJOR ALTERNATIVES

Area of Impact	Proposed Action	Chatfield Alternative	Upstream Alternative	Water Conservation Alternative	No Action Alternative
SOCIO-ECONOMIC					
No. of jobs for 3 years	460 jobs (maximum) 317 jobs (Average Annually)	250 jobs	300 jobs	143-153 jobs between 1980-2010	0
Water shortage days in 1990	0	0	0	None	40 days
2000	0	0	0	None	63 days
Date raw water becomes limiting factor	1988	1988	1988	1990	1990
Electric Energy (per year)					
At 125 mgd:	Produce: 11,000,000 kwh	0	0	NA	0
	Use: 8,000,000 kwh	58,773,000 kwh 1/	8,000,000 kwh	NA	0
	Surplus: 3,000,000 kwh	0	0	NA	0
At 500 mgd:	Produce: 28,000,000 kwh	0	0	NA	0
	Use: 13,000,000 kwh	216,066,000 kwh 1/	13,000,000 kwh	NA	0
	Surplus: 15,000,000 kwh	0	0	0	0
Overall cost in 1976	$234 million	Estimated to be $100 million more than proposed project.	2/	2/	None
WATER					
1988 average annual flow in the South Platte above the Platte Canyon intake	328 cfs	521 cfs	328 cfs	328 cfs	521 cfs
AQUATIC RESOURCES					
Miles of stream lost	1.7 miles	None	0.5 miles	None	None
Replaced by acres of reservoir	95 acres	NA	8 acres	NA	NA

1/ This does not include carbon regeneration.
2/ Unquantifiable without additional data.

TABLE 8-1 (cont.)

COMPARISON OF IMPACTS OF THE PROPOSAL AND MAJOR ALTERNATIVES

Area of Impact	Proposed Action	Chatfield Alternative	Upstream Alternative	Water Conservation Alternative	No Action Alternative
Geology, topography, and minerals	Speculating prospecting for iron, copper, or uranium would be impossible for at least 75 years	None	None	None	None
SOILS					
Sediment yield (additional above present for project life) 125 mgd	1,752.6 tons	1,175 tons	1,793 tons	NA	None
500 mgd	3,886.3 tons	1/	3,926.7 tons	NA	None
TERRESTRIAL RESOURCES					
Vegetation permanently lost 125 mgd	193 acres	65 acres	75 acres	NA	None
500 mgd	582 acres 2/	1/ 2/	584 acres 2/	NA	None
Vegetation temporarily lost (3-5 years) 125 mgd	387 acres 1/	313 acres 2/	389 acres 2/	NA	None
500 mgd	582 acres 2/	1/ 2/	584 acres 2/	NA	None
Type of bighorn habitat limited during construction	Summer range Winter range Lambing Grounds Breeding areas	None	Summer range	None	None
Reduction on bighorn population	From 60-65 to 30 head	None	from 60-65 to 45 head	None	None
Golden eagle eyries disturbed	One eyrie	None	Two eyries	None	None
Loss of habitat for other species in miles of canyon bottom	4 miles	None	8 miles	None	None

1/ Data not available for 500 mgd for Chatfield.
2/ The second parallel conduit would redisturb a portion of these habitat acres; it is not quantifiable.

TABLE 8-1 (cont.)

COMPARISON OF IMPACTS OF THE PROPOSAL AND MAJOR ALTERNATIVES

Area of Impact	Proposed Action	Chatfield Alternative	Upstream Alternative	Water Conservation Alternative	No Action Alternative
CLIMATE AND AIR QUALITY	Air quality in the construction area will be degraded by dust and vehicle emissions in amounts too small to measure	Same as proposed action	Same as proposed action	Air quality in Metro Denver would be degraded due to increasing amounts of fugitive dusts.	Same as Water Conservation Alternative
NOISE					
Intermittent noise levels in construction area	90 dBA	90 dBA	90 dBA		
VISUAL RESOURCES				Could have extensive visual impacts in the service area due to degraded air quality from fugitive dusts.	Same as Water Conservation Alternative
Inundation 125 mgd	Low	Low	Low		
500 mgd	Moderate	Moderate	Moderate		
Dam	High 1/	None	High 1/		
Access Roads	High	Low 2/	High		
Staging area	High	None	None		
Water treatment facility 125 mgd	High 1/	High 1/ 2/	High 1/		
500 mgd	Low	Low 2/	Low		
Conduit No. 27 2nd Parallel Conduit	Low	Low 2/	Low		
Tunnel muck disposal	Low	None	High 1/		

1/ Indicates a contrast in excess of BLM standards for the area and visual management class involved.
2/ Alternate location.

TABLE 8-1 (cont.)

COMPARISON OF IMPACTS OF THE PROPOSAL AND MAJOR ALTERNATIVES

Area of Impact	Proposed Action	Chatfield Alternative	Upstream Alternative	Water Conservation Alternative	No Action Alternative
CULTURAL VALUES					
Archaeological features lost	Undiscovered features lost; cannot be quantified	None	Undiscovered features lost; cannot be quantified	1/	None
Historical features lost	515 miles narrow gage railroad grade (DSP&P, D&RG, Deansbury Sta., Strontia Springs site, Keystone Bridge)	None	1/2 mile narrow gage railroad grade (DSP&P, D&RG)	1/	None
Paleontological features lost	Undiscovered features lost; cannot be quantified	None	Undiscovered features lost; cannot be quantified	1/	None
RECREATION					
Visitor days lost during construction	18-36,000 (3-year construction period)	367,233 to 2 million (1-year construction period)	40-80,000 (4-year construction period)	1/	None
LAND USE					
Land use options lost	727 acres	312 acres	588 acres	1/	None

1/ Unquantifiable without additional data.

Chatfield Alternative

Description

As an alternative to the proposed action, a treatment plant and pumping station could be constructed at Chatfield Reservoir, 12 miles downstream from the proposed Strontia Springs Dam. Raw water would be pumped from Chatfield Reservoir and piped about 7,000 feet to a treatment plant located between West Plum Creek and the South Platte River (Map I-3). Two raw water conduits, 108 inches in diameter, would link the intake tower to the treatment plant. The intake tower and pump station would be located southeast of the existing Chatfield Dam intake tower (Map I-3). The tower would be 120 feet high (to ensure it being above the flood pool level) and would include trash racks. Pumps would be capable of lifting water from the 5,426-foot elevation at the intake to and through the filter plant to the operating elevation of 5,860 feet (104 feet). Chatfield Reservoir would have to be drained for about one year to allow for construction of the intake structure, pump station, and intake conduits.

The water treatment plant would be similar to the proposed Foothills plant; however, filtration capacity would have to be substantially greater because of lower water quality. About 200 acres of land would be required for the plant with no buffer. Access would be by existing roads. As opposed to the online or base nature of the proposed Foothills plant, the Chatfield facility would be employed as a peaking plant, operated as needed to ensure that demands for water would not exceed base-treated capabilities at Moffat and Marston.

The Chatfield alternative would require large amounts of electrical energy to accomplish the required pumping. Annual energy consumption would range from about 67,000,000 kilowatt-hours initially at the 125 mgd level to about 273,000,000 kilowatt-hours at the 500 mgd level of plant capacity. These figures include the necessary energy requirements for carbon-regeneration at this plant and the pumping that the Foothills plant could eliminate from the existing system. To help put this in perspective, the DWB's total consumption during 1975 was about 48,000,000 kilowatt-hours.

The pumping lift capacities of this alternative would be as follows: (1) Intake in Chatfield at 5,426 feet elevation to plant at 5,530 feet elevation or 104 feet plus 30 feet head loss would be a total lift capacity of 134 feet, and (2) plant discharge would be at 5,530 feet elevation to Highlands Distribution Center at 5,800 feet

elevation or 260 feet plus 60 feet of head loss for a total capacity of 320 feet.

Because congressional approval is needed to make a change in the utilization of Chatfield Reservoir, as well as new design and engineering requirements and environmental statement, the DWB estimates that a plant at the Chatfield site could not be operational until 1986.

Treated water would be pumped from the treatment plant to the Hillcrest Reservoir via an alternative Conduit No. 27 (Map 1-3) and the required portion of Conduit No. 27. The alternate 108-inch conduit would follow Roxborough Park Road south to Titan Road and then turn east to intercept the proposed alignment of Conduit No. 27. The total length of Conduit No. 27 would be about 15.5 miles (5,000 feet less than proposed). The design for an alternate Conduit No. 27 would be the same as for the proposal.

The Chatfield alternative would provide a minimum of 4,000 acre-feet of storage. As much as 24,000 acre-feet of storage capacity could conceivably be utilized without the approval of Congress, but 20,000 acre-feet of this capacity is allocated to 100 years of sedimentation and theoretically would not be available after that period. Use of more than 24,000 acre-feet would require congressional approval. However, any facilities needed to make use of this water would require congressional approval.

Analysis

Socio-Economic Conditions

Social and economic impacts would occur both during the three-year construction period and during the life of the project. There would be significant human and social impacts on about 250 families or individuals who would receive average gross incomes of not under $16,000 (Table 2-2). Present trends in water consumption could be continued until about 1988.

The Chatfield alternative would have other socio-economic implications in that the gross cost of construction would be about 60 percent higher. There also would be additional operational costs due to large amounts of electrical energy needed for pumping. Also, higher concentration of pollutants at Chatfield would entail more complex and expensive treatment processes. The foregoing circumstances would result in higher costs to DWB water users.

Water Resources, Aquatic Resources and Soils

Because the existing treatment plants would function as base plants, most of the raw water for treatment would be diverted at the existing Platte Canyon and Highline Canal Intakes. Flows below these points would be increased only during periods of peak demand.

Flows through the Waterton Canyon and into Chatfield Reservoir would probably bring about increased bank erosion, channel scouring, and sedimentation rates, with the result that the 100-year projected life of the reservoir would be somewhat reduced. The full extent of this impact is contingent upon the intensity of use of the treatment plant and the commitment requirement for raw water. Since lows of equal magnitude would occur in the canyon to the South Platte Intake without the project, the impact there is only one of timing, i.e., impacts related to high flows would occur earlier than without the project. Below the South Platte Intake, higher flows would occur on the peak demand days, when, without the project, shortages would occur (Table 1-5).

The quality of water in the South Platte River would be degraded in the 12 miles of travel from the proposed Strontia Springs dam site to Chatfield Reservoir. In addition, the present quality of water entering Chatfield Reservoir from Plum Creek is inferior to that from the South Platte. Water stored in Chatfield also would be subject to increased growth of algae. Contamination from recreational use at Chatfield and urban runoff entering the water supply from the intervening drainages would necessitate more complex treatment processes. In particular, activated carbon treatment would be required to treat water stored at Chatfield.

Prohibition of primary contact recreation could make Chatfield more attractive from the health standpoint but would raise objections from the recreation public. No existing federal or state laws deal with the problem of public use of terminal storage reservoirs, and such use is not uncommon in the eastern United States. However, the Colorado Department of Health, the Denver Department of Health and Hospitals, and the DWB are opposed to recreational use of terminal storage reservoirs.

In the areas disturbed during construction, the sediment yield would be increased 1,175 tons over present sedimentation rates and deposited in Chatfield Reservoir. Considering the volume of water in the South Platte, the increased turbidity and effects on aquatic habitat would not be measurable. Higher flows below the Platte Canyon Intake would result in additional scouring action in that section of the river which suffers from excessive amounts of sand (from flushing sediments out of intake structures) and from low flows. Aquatic habitat in the stream below these intakes would be improved as bottom sediments were swept downstream into Chatfield Reservoir.

Geology, Minerals, and Topography

This environmental element would be impacted to an insignificant and unquantifiable degree by this alternative.

Terrestrial Resources

Construction of the Chatfield alternative would result in 65 acres of terrestrial habitat (grassland) being committed to space for permanent structures. About 313 acres would be disturbed for a three-year period; however, reclamation measures would mitigate permanent impacts. Since there would be no construction in the South Platte Canyon, impacts on wildlife would be restricted to plains species, i.e., prairie dogs and antelope. As with the proposed action, the trench for Conduit No. 27 would be excavated through two prairie dog towns and across a corner of the known antelope range.

Climate and Air Quality

In the construction area at 125 mgd and 500 mgd, air quality would be degraded by dust and vehicle emissions in amounts too small to measure.

Noise

Noise levels after completion of construction probably would not exceed the level of 50 decibels, adjusted (dBA), which is only slightly higher than ambient noise levels. These impacts cannot be mitigated to any particular extent. However, for the purposes of this analysis, they are of relatively minor importance and should have little effect on the overall Chatfield recreation plan.

Visual Resources

As indicated on Table 8-1, the visual impacts of this alternative would be comparable to those of the proposed action for power transmission and telephone lines, the water treatment facility, alternative Conduit No. 27 and increased drawdown of Dillon Reservoir. Due to the construction of the roads on the plains instead of in Waterton Canyon, visual contrast resulting from construction of access roads would be low.

Cultural Resources

Although no known historical features would be affected, archaeological sites and/or possible paleontological values could exist on the areas to be disturbed. At present 20 extant sites have been identified by previous surveys in this area. A total of about 312 acres would be subject to disturbance and loss of archaeological and paleontological values. By law, E. O. 11593, inventory would be

required prior to earth disturbance, and Section 106 compliance is mandatory before the project can begin.

Recreation Resources

The draining of Chatfield Reservoir during construction of the alternate intake and conduit would result in the loss of the aquatic habitat and most recreational opportunities associated with that body of water for one year. The actual amount of recreational opportunities lost during construction is difficult to determine. Ultimate visitation to the reservoir is predicted to be 2 million visitors annually by 1990. However, this would require the state to maintain 1,300 surface acres at the reservoir. The state currently does not have sufficient water, and total use between July 1976 and July 1977 was 367,233 visitors. During the construction year, these visitors would have to recreate at similar facilities in the metropolitan area such as Cherry Creek Reservoir. The additional visitors at these alternate recreation areas could produce adverse impacts associated with increased use.

In addition, the draining would create unattractive mud flats. These flats would affect aesthetic values and would be noticeable to occupants of an estimated 7,150 vehicles using State Highway 75 each day of the construction year, or a total of 2.6 million vehicles. After the refilling of Chatfield Reservoir to its previous level, about one year would be required for the reservoir to regain the aquatic productive potential.

Construction, maintenance, and operation of the treatment plant would conflict, to some extent, with the open space and limited access facets of the Corps of Engineers' recreational plan for the Chatfield Project. The proposed plant site would be located on about 200 acres of land designed as open area and would abut lands designed for overnight use and natural or environmental study (Corps of Engineers 1974).

Land Use

Table 8-1 summarizes the development of the Chatfield Dam alternative. As with both the project proposal and the No Action alternative, major topographic, social and economic factors other than presence or absence of any part of the project would control general land use except for the areas actually occupied by project features.

About 252 acres of land presently being used for grazing and about 60 acres of land being dry farmed would be committed to a municipal water works. This would preclude using these lands for other purposes during the life of the project.

At 125 mgd, 75 acres would be used by installation of Conduit No. 27 and at 500 mgd an additional 75 acres would be used for the additional conduit.

It is probable that urban growth would continue at its present rate, that is, areal urban development of 73 acres annually within one mile of Conduit No. 27 and the second parallel conduit and a lineal growth rate of about .1 mile annually from north to south.

Upstream Dam Alternative

Description

Another alternative to the proposed action would involve construction of a lower dam farther upstream from the Strontia Springs site. The treatment plant would operate as a peaking plant and would have the same design as the proposed plant. The diversion dam, located about 10,500 feet upstream from Stevens Gulch and about 200 feet upstream from the city of Aurora's existing water intake for the Rampart Tunnel, would be a concrete gravity dam with the entire section acting as an uncontrolled overflow spillway. At an elevation of 6,030 feet, the dam crest would be 50 feet above the streambed with a crest length of approximately 200 feet.

The intake for the tunnel would be an integral part of the dam structure, located approximately at the 6,030-foot level. It would feature a simple gated inlet equipped with a trash rack. Sluice gates would be installed in the center of the dam.

At the crest elevation of 6,030 feet, the reservoir would extend about 2,500 feet upstream from the dam, inundate approximately 8 acres of lands, and contain 97 acre-feet of water. The reservoir would have little sediment-settling capabilities as water turnover would be rapid. Accumulated sediments would have to be removed each year by dredging to maintain the diversion facility. The reservoir has a trap efficiency of 10 percent; it would trap about 7,000 tons of sediment annually.

All vegetation below the 6,030-foot elevation would be chipped, removed, and scattered over disturbed areas above the high-water line of the reservoir. About 8 acres of brush with a few scattered Douglas-fir trees would need to be cleared.

Construction of the dam would require about 15,000 cubic yards of concrete and 125 tons of steel. Concrete would probably be hauled in from a staging area at South Platte to a 2-acre staging area that would be located in the canyon near the dam site.

The west portal of the tunnel would be located just upstream from the right abutment of the dam, while the east portal would remain in the same location as it is for the proposed project. No other portals would be necessary. Tunnel alignment would follow a nearly straight line between the two portals. Tunnel length would be approximately 26,500 feet. With a pay line of 10.5 feet in diameter to blasted rock and a finished inside diameter of 8.5 feet, the concrete-lined pressure tunnel would have a capacity of about 1,100 cubic feet per second (710 mgd). Construction of the tunnel would proceed

simultaneously from both portals. Approximately 38,500 cubic yards of tunnel muck would be taken from each portal. Muck from the west portal, together with about 23,000 cubic yards of material excavated from the dam foundation, would be deposited on DWB property along a sand bar near the confluence of the South Platte and its North Fork. Approximately 7 acres would be covered to a depth of about 5.5 feet. Site reclamation and runoff preventatives would include providing cutoff trenches to prevent drainage, replacing topsoil and revegetating. Muck removed from the east portal would be deposited at the site selected for the proposed project tunnel.

Operation of the treatment plant would produce about 16,100 pounds of sludge per average day at 125 mgd and 38,600 pounds at 500 mgd per average day. Sludge drying ponds would be cleaned three to four times annually. During the life of the project, about 15 acres in the disposal area would be filled and leveled at 125 mgd and 90 acres at the 500 mgd level.

Winter icing conditions would cause this diversion structure to be operative for only seven months of the year and necessarily change the Foothills Treatment Plant operation strategy.

Silt in the structures and severe erosion of values would be of major concern because diversion structures of low volume greatly increase operational problems where silt is concerned. An example of this is the Aurora tunnel. The tunnel's capacity has been seriously affected by silt. The DWB is currently faced with this problem in their existing diversion structures.

Primary access to the dam site would be from Sedalia through Nighthawk, approaching the dam from the southwest. Although this route has a steep grade at Nighthawk, a historical site, it would be improved to accommodate construction traffic. About 5 miles would require substantial improvement and realignment and would affect about 30 acres. From the town of South Platte, which is within the North Fork Historic District, to the dam, the road would be improved to a width of 14 feet with turnouts.

A second access route would be from Kassler through Waterton Canyon. Although this route is shorter, the road would require some improvement in order to upgrade it to a 22-foot road with turnouts. Public access would not be permitted along this route until after the construction period.

A 13.2 kilovolt aerial powerline would be constructed from Platte Canyon Intake to provide power required for construction of the dam and west tunnel portal. This permanent powerline would provide power needed at the dam for operational purposes.

Construction time and manpower for the alternate tunnel would be about 60 percent greater than that required for the proposed project tunnel. Construction for the dam would require about one year. The overall construction schedule for the project would not change. Overall this alternative would employ an average of 300 persons for over four years.

The operation of the upstream diversion system and treatment plant would require the use of about 8 million kilowatt-hours of electricity annually, which would be purchased from electric power companies in the area. This would represent a long range commitment of energy sources that are being depleted to generate electricity. No new energy sources would be developed with this alternative.

Analysis

Socio-Economic Conditions

Social and economic impacts similar to those described for the Chatfield alternative would occur if this alternative were pursued. There would be significant human and social impacts on about 300 families or individuals who would be employed and receive average annual incomes amounting to about $16,000. Trends in water consumption and water shortages would be the same for both alternatives as they both provide treatment capability approximately equal to the proposal.

The Upstream Dam alternative would have additional socio-economic implications in that the gross cost of construction would be higher due largely to the fact that 2 more miles of tunnel would have to be dredged annually and it would not have any electrical generation capacity as would the proposed project. The foregoing circumstances would result in higher costs to DWB water users.

Water Resources

By 1988 average annual flows in the South Platte River below the upstream dam would be 521 cubic feet per second (cfs) without the project. Below the point of diversion, flows would be reduced to 328 cfs, as 193 cfs (at 125 mgd) would be diverted to the treatment plant. Reduced flows would be experienced in the 6-mile stretch of river between the upstream dam and the existing Platte Canyon and Highline Canal diversions.

Aquatic Resources

Approximately 2,500 feet of productive trout stream in the South Platte River would be converted into a rapid water exchange reservoir

with low aquatic productivity. The standing crop of fish would be reduced from about 64 pounds per acre of naturally reproduced rainbow and brown trout to approximately 21 pounds per acre. Spawning gravels would be lost in the 2,500 feet of river that would be inundated.

The reduction in flows from 521 cfs (without the project) to 328 cfs in the 6-mile stretch of river between the upstream dam and the Platte Canyon Intake would probably result in decreased amounts of aquatic habitat and production. Since cross-sections of the channel are not available, the exact amount of loss is unknown.

Geology, Minerals, and Topography

In the construction area at 125 mgd and 500 mgd, no significant impacts would be encountered.

Soils

During the two-year construction period and then once each year thereafter, when sediments are dredged from the reservoir, turbidity in the river below the upstream dam would increase. Suspended sediments would be carried about 200 feet downstream into the pool created by Aurora's diversion dam and intake structures. Although the heavier sediments would drop out, the increased turbidity would be carried downstream. The net impact on Aurora's facility would be increased sedimentation rates during the operational phase. In an estimated 25 years or less, the sediments obtained from dredging would completely fill the borrow pit near Kassler. This would positively affect aesthetic values by returning that pit to the original shape of the land. Use of other, subsequently located pits for that purpose would probably result in similar positive impacts.

During normal operation of the facility, turbidity would be slightly decreased by the limited settling capacity of the 8-acre reservoir. However, it probably would not be measurably different from the present level (8 JTU (Jackson Turbidity Units)).

Terrestrial Resources

Construction of the Upstream Dam alternative would result in the permanent loss of 75 acres of terrestrial vegetation to permanent project features such as the dam, reservoir, roads, and treatment plant facilities. Another 389 acres would be disturbed temporarily during construction. However, after a three- to five-year reclamation period, the disturbed areas would be returned to a productive state. During construction and reclamation, sediment yield from disturbed areas would result in 1,793 tons of sediment being transported into the river. The resulting increase in turbidity cannot be estimated.

Construction activity at the dam site and west portal of the tunnel would result in harassment of bighorn sheep. These sheep would probably abandon the portion of their summer range in the lower part of the canyon between the dam site and South Platte as a result of the construction activity. Since summer range is relatively more plentiful than winter range, extreme stress and increases in disease levels would not be expected. However, the bighorn sheep herd could possibly be reduced from 60-65 head to 45 head as a result of the increased crowding, stress, and possible poaching.

During the construction phase, possible use of the area for feeding by peregrine falcons would be precluded. The 8-acre reservoir could provide a minor amount of feeding area for the peregrine falcon as it would attract waterfowl, shore birds, and swallows. Two known golden eagle eyries would be disturbed. Nesting eagles in the area would be forced to use alternate eyries outside the area. Since suitable alternate nesting sites are common in the general area, the impact would be minor.

Other wildlife species, including deer, bear, and mountain lion, would be driven from the canyon bottom between South Platte and Kassler as a result of increased human harassment. In the 8-acre construction area at the dam site, less mobile species probably would be lost as they would not be able to find unoccupied niches.

Climate, Air Quality, and Noise

In the construction area at 125 mgd and 500 mgd, air quality would be degraded by dust and vehicle emissions in amounts too small to measure. Noise levels as high as 90 dBA would occur intermittently in the construction area. Wildlife probably would avoid areas where noise levels exceed ambient levels.

Visual Resources

The anticipated visual impacts for the dam and reservoir identified in this alternative would be less than those identified for the same features in the proposal due to the smaller size of the alternative's features (Chapter 3, Visual Resources). Although the impacts would be reduced, it would not be enough to reduce the visual contrast points shown in Table 3-13.

Since the dam site staging area would be inundated after the dam's completion, no long-term visual impacts would be realized.

The deposition site for tunnel muck and material excavated from the dam foundation would become an unattractive visual intrusion at

the confluence of the North Fork of the South Platte and the South Platte Rivers. The short-term visual contrast generated by this would probably exceed the 16 points maximum established for this area (Table 3-13). This feature's location corresponds to the area analyzed in Table 3-13 for inundation and increased stream flows. The area is located in a visual management class III area, as shown on Map 2-11 and described in Table 3-13.

Although rehabilitation of the site would reduce the visual contrast, the cutoff trenches would have a reverse effect and could result in a long-term contrast that is still higher than BLM standards for maximum contrast levels.

Improvement of the road between Sedalia and Nighthawk would probably not produce excessively high visual contrasts as long as the existing alignment would be followed. When the final alignment would not coincide with the original, it would be likely that excessively high visual contrasts would result. Visual contrast of the access road in Waterton Canyon would be the same as described in the proposed action.

Cultural Resources

The Deansbury Bridge would be removed from context, about one half mile of the abandoned narrow gage railroad grade would be inundated by the reservoir, and the railroad grade would be blocked by the upstream dam. The integrity of the system would be lost as the result. Unknown archaeological and historical values could be disturbed in the 30 acres required for construction of the road through Nighthawk. There could be adverse impacts on archaeological and paleontological values. Because Nighthawk is a historical site and the area around it would be disturbed, Executive Order 11593 requires an inventory prior to ground disturbance. The road between South Platte townsite and Nighthawk is the old DSP&P railbed, and, while it has been modified for an auto road, care must be taken in widening the site. Further, the upper end of the road improvements at South Platte are in the North Fork Historic District and therefore would require a 106/2b statement of effect.

Recreation Resources

Closing Waterton Canyon to public access during the four-year construction period would result in the loss of between 40,000 and 80,000 high quality visitor use days. These recreational visits would have to be absorbed elsewhere. Increased use in other areas could result in degradation of facilities, vandalism, and a recreational experience of lower quality. Long range impacts would be the same as for the proposed action.

Land Use

About 588 acres of land presently being used for grazing, open space and recreation would be committed to use for municipal water diversion and treatment facilities. Future land use options on this area would be precluded during the life of the project. However, the lands in the canyon and along the conduits would be available for public recreational use. Other land use impacts would be identical to the proposal.

Water Conservation Alternative

Description

As an alternative to the proposed Foothills Project, the following conservation program is proposed. Modifications of the amount of consumption would be achieved through various conservation practices to the extent necessary to keep total quantity demanded within the capacity of existing water treatment facilities.

The particular conservation elements chosen by the Denver population, and in what combinations, would be determined by social values and political and economic factors. A scenario is presented (Table 8-2) that is intended to present one possibility for the implementation of these elements, the general time period in which they could become necessary, and the various levels at which each could be enacted.

Meters would be installed in the 89,000 unmetered homes of the DWB service area. Optimum application of dual systems of distribution would occur, and amendments would be made to building codes. Storage facilities would be built to aid in meeting demand during peak periods. Public education would become a function of the utility, with educators instructing people in the methods of conservation. A pricing system would be instituted to modify demand. Rationing would be employed.

Analysis

Meter Installation

A primary component of conservation as an alternative to the proposed Foothills Project is universal metering of the presently unmetered 89,000 homes in the DWB service area. This universal metering is a necessary prerequisite to the imposition of a pricing structure. It also provides the DWB with data to implement other conservation measures (Brannan 1977).

On November 29, 1977, the Denver Water Board made the following public announcement regarding metering:

> If Water Board contracts with the plumbing industry for meter installations and determines placement of meter, the estimated cost is $21 million. This estimate has been reached as follows:

Inside meter installation, 62,300 customers, AVERAGE COST, $125.00.

Outside meter installation, 16,000 customers, AVERAGE COST, $200.00.

Outside meter installation requiring service line replacement. Estimated 12% or 10,700 customers, AVERAGE COST, $900.00.

If meters were installed through arrangements made by each resident individually, and each customer obtaining his own plumber, the total cost could be as high as $36 million. This estimate has been reached as follows:

Inside meter installation, 62,300 customers, AVERAGE COST, $250.00.

Outside meter installation (No service line problems), 16,000 customers, AVERAGE COST, $480.00.

Outside meter installation requiring service line replacement. Estimated 12% or 10,700 customers, AVERAGE COST, $1,200.00."

The Denver Water Board, at this time, has no public information available concerning a plan to finance this project but is pursuing federal funding in the form of grants (personal communication, Parsons and Weir 1977).

Among these 89,000 homeowners, an impact of disruption and inconvenience would occur. There could be a visual intrusion, particularly if service lines had to be replaced. The exact economic impact of meter installation cannot be addressed at this time because the method of financing is presently unknown.

No direct economic impact to homeowners would result if the project were financed entirely with federal funds. However, if the maximum average installation cost of $1,200 were incurred entirely by the homeowners, the impact would be extreme. Moreover, the average age of unmetered homes in Denver is 45 years (DWB 1977). It is assumed that many of these homes would require service line replacement in addition to metering. In addition, many of these homes are owned by people with low or fixed incomes. The impact to these homeowners would be extreme.

The ability of the DWB to measure total volume and identify system leaks would result in a positive impact. According to a report prepared by the Metropolitan Denver Water Study Committee (1975),

"Losses also contribute to the total water requirements. The losses which occur in the treated water portion are called system losses and may be due to leakage from mains and treated water reservoirs, inaccurate retail meters, flushing the water system, and street and sewer cleaning. Losses of this type commonly range from six percent to 12 percent and are included in the per capita treated water requirements."

Over and above the savings of a limited resource which accrue to society as a whole, metering could induce a greater degree of equity among the consumers, each household paying for the amount of water consumed. This could result in increased water bills for some households and decreased bills for others, in accordance with the level of use.

Another positive impact would be realized by increased employment among the various sectors. Companies that manufacture, market and install the water meters would hire additional personnel to meet the increased demand for meters. The DWB would need to hire additional personnel to administer, read and maintain the meters. In a plan to meter over a five-year period, the DWB estimates employment of 100 to 110 contractor personnel, 43 board personnel, and 31 pieces of additional equipment.

<u>Pricing</u>

While extensive studies would be necessary to determine the exact impacts of any pricing tool, certain impacts may be theorized. Very little definitive information is available concerning the demand for water and the consumer's response to changes in the price of water. This demand is very closely related to consumer income, the climate of the region, the technological limitations of reducing use in the home, the age of the home, and many other factors. The pricing tool which most effectively modified demand could be developed only by a site-specific study which incorporated these variables.

Three pricing mechanisms would be considered: progressive, peak and surcharge pricing. The Denver Reasearch Institute (DRI) has reported the following:

"Progressive pricing, also known as 'inverted' or 'increasing,' block rates apply a specific price to each block of water used by a consumer. The applicable price for each block rises with each successive block. . . . The range of consumption in each block and the relation between prices of the various blocks will determine the savings in water use." Summarized, a program of this sort could be manifested as follows:

"(1) A relatively low price would be set for the amount of water typically used in-house.

"(2) A higher price would be set for a minimal amount of lawn watering, based on an average lawn area and an estimate of the amount of sprinkling needed to maintain that lawn.

"(3) For any amount of water used over and above domestic use and reasonable sprinkling of a moderate sized lawn, a third and higher price would be set. Obviously the higher the price the more prohibitive it would be of any tendency to overwater, or to increase lawn size." [Denver Research Institute 1977].

The effects associated with this pricing tool include the following:

A reasonable estimate by the DRI indicates that a statewide drop in municipal water demand could reach 7 percent. It should be noted that the conservation achieved would be primarily from single family dwellings, impacting horticultural uses of water. Should this system be implemented year round, particularly if the increases in successive block prices were large, the impact on users of water for summertime irrigation could be extreme. Extensive conversions in landscape styles to plant species adaptable to a semi-arid environment could occur. Increased planting of ground cover could also be expected.

Peak responsibility pricing places a seasonal price differential on water prices, thus modifying demand by as much as an estimated 10 percent (DRI 1977). The differential exists in that the price of water consumed per unit is higher in summer than in winter. (A comparable peak pricing system has been instituted by some electrical utilities, charging more for electricity consumed during daylight peak demand hours than for that consumed during the early hours of the morning, when total demand is very low.)

Horticultural impacts could occur in a comparable manner with this pricing tool. A beneficial impact of this tool is the modification of "peak demand," a concept central to planning supply of utilities. If the peaks can be modified, the need to expand service to meet those peaks will be delayed.

Surcharges are a third tool which could be used to modify demand. They are temporary impositions, most successful when much greater than the base price, which are used during periods of critical demand. DRI estimates that quantity demanded can be reduced by about 12 percent with surcharges. If a particularly hot and dry month leads the utility to believe that total quantity demanded may exceed the capacity of the system to treat and deliver water, an extra charge may

be "tacked on" that billing period. If this is a significant increase, and the public is aware of the imposition, it can act as a significant disincentive to consuming water.

A negative impact of surcharges is that they are not perceived by the public as permanent; hence demand may be modified during critical periods, but there is no long-term incentive to modify patterns of consumption. A positive impact may occur among the sector which places a very high value on present styles of landscaping, as one cannot assume that these would be permanently and extensively converted. There could be increased administrative work associated with surcharges, as well as the necessity to notify the public and educate them regarding the goal of a surcharge.

There are impacts which could occur as a result of any of these three tools. An economic hardship would be experienced by individuals on fixed incomes. A household with a fixed income may risk losing their landscape investment if they cannot afford the increased cost of water, or they may choose to transfer their portion of income from other goods and services which they are consuming. A beneficial impact would result in that the basic needs in household uses to meet health and safety standards would not be severely reduced. A beneficial employment impact could occur among landscape architects and the other sectors of the economy that deal with landscaping. While there could be a visual impact in the appearance of landscapes, it may not be as extreme as anticipated. "As much as 20 percent of irrigation water may represent overwatering" according to the DRI (1977). Lawn sizes could be smaller in the long run, and there could occur increased use of public recreation spots. There could occur an increase in the fugitive dust levels, as trees and grass "hold" a large amount of this dust.

A positive social impact would occur with a pricing mechanism in that individuals would be free to allocate their incomes as they chose, theoretically reflecting the value placed upon water consumption in relation to consumption of alternative goods and services.

Treated-Water Storage

Throughout the Denver metropolitan area, treated-water storage reservoirs would be built with the necessary interconnecting distribution lines and pumping stations. This system would treat raw water at the existing DWB plants over a 120-day period in the spring when max-day volumes are lower. This system would store the water online in the distribution system and deliver it throughout the summer when high max-day demands are placed on the system. Each reservoir would have a capacity of 50 mg, considered the optimum size of treated-water reservoirs (DWB 1977). Six reservoirs would be needed

in the year 2000 to meet max-day demands in conservation; 40 reservoirs would be required in 2010.

Specifically, each reservoir would require a 12-acre site. Each site would have a concrete-covered tank (reservoir), a pumping station, a redisinfection station and a 25 to 50 mgd capacity conduit (approximately 36 inches in size) leading into the system. The 36-inch conduit would be needed to place the treated water into the system at a rate which would meet the max-day volumes (DWB 1977).

In addition, an unquantifiable number of conduits would be built from the treatment plants to these various storage sites.

Because of elevation differences, it would be necessary to lay a great deal of high pressure pipe. This pipe, for the most part, would be laid in existing streets.

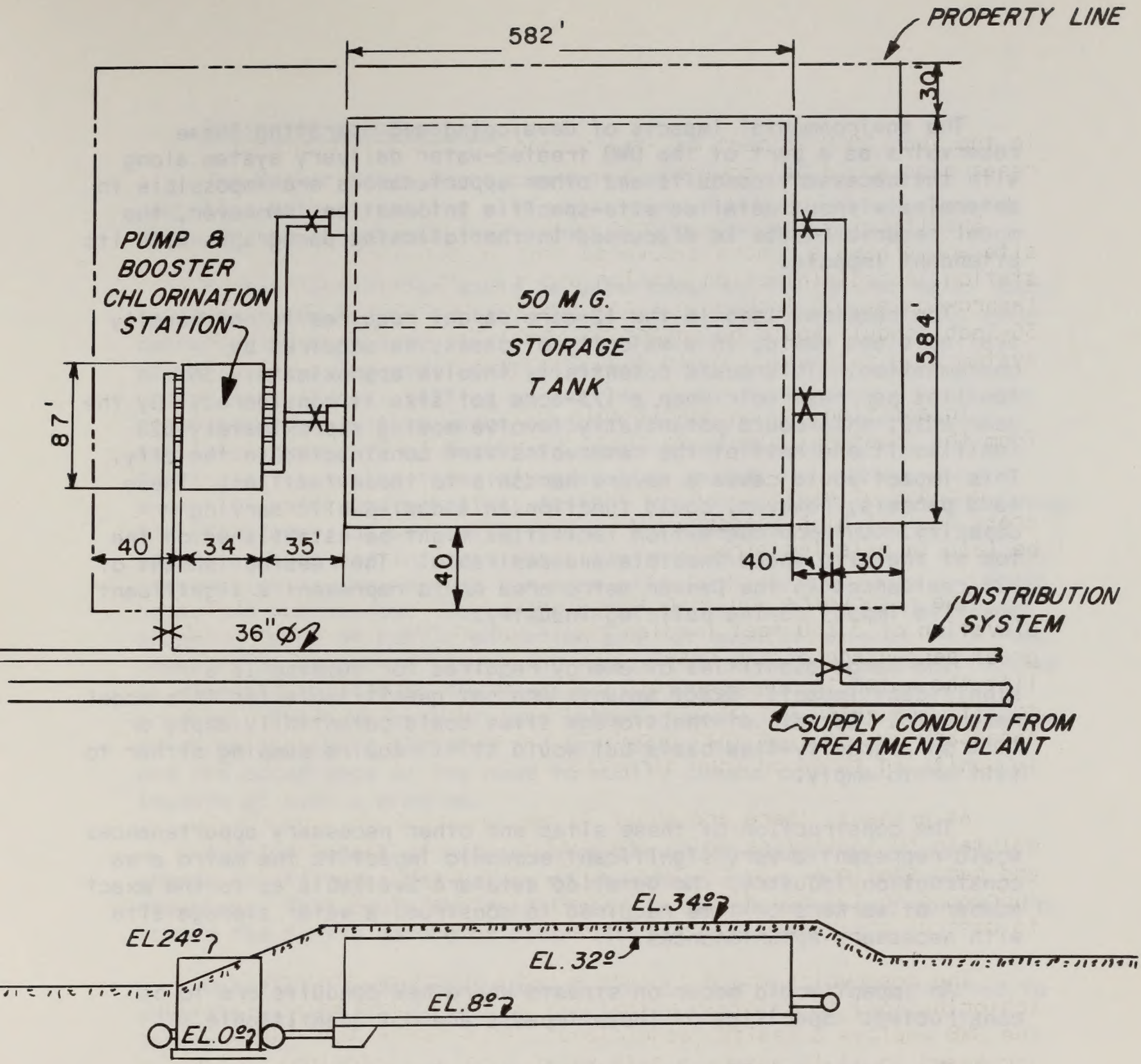
The reservoirs would include a pump station assuming an average elevation of 5,550 feet (median elevation of the DWB system). In a great percentage of the cases, pumping would be involved either to lift the water to the reservoir or, as in the case of low reservoirs, to lift the water out of the reservoirs. This is made even more necessary by the fact that growth tends away from the core city, which is uphill in three or four directions.

At present, there are about 70 men employed who operate and maintain 50 facilities which are similar to the proposed reservoirs and pump stations. By the year 2010, this number would have to be increased to 133 men within the control system which would be required to control pressures, levees, flows, and pumps.

The reservoirs would include a redisinfection station (chlorination) to maintain potability of the stored water. Currently, the DWB employs 8 health technicians. This number would have to be increased to 17 to assure a safe water supply. Chlorinators require regular maintenance and, because of remote locations, chlorine residual analyzers must monitor all outgoing water at each reservoir.

The model reservoir site (Figure 8-1) is shown to illustrate the nature of one of these treated-water storage reservoirs.

The approximate cost of the implementation of this portion of this alternative, including storage reservoirs, all appurtenances necessary to bring water to the reservoirs, maintain the water in a safe condition, and then deliver the water online into the system, is approximately $1.38 billion. This would cost the DWB service area consumer between the years 2000 and 2010 approximately $962 per capita.



$$\text{SITE ACREAGE} = \frac{\overbrace{(40+34+35+582+40+30)}^{761'}\ \overbrace{(40+584+30)}^{654'}}{43560} = \frac{497694}{43560} = 11.42 \text{ Acres}$$

SAY MIN. 12 ACRES

MODEL 50 M.G. TREATED WATER STORAGE RESERVOIR SITE

SOURCE: DWB, NOV. 77

FIGURE 8-1

The environmental impacts of developing and operating these reservoirs as a part of the DWB treated-water delivery system along with the necessary conduits and other appurtenances are impossible to determine without detailed site-specific information. However, the model reservoir site is discussed in the following paragraphs with its attendant impacts.

The required land in the 12-acre parcel required is not readily available and would, in a majority of cases, be acquired by condemnation. This could potentially involve approximately 36 families per reservoir when a 1/3-acre lot size is considered. By the year 2010, this could potentially involve moving approximately 828 families if one half of the reservoirs were constructed in the city. This impact would cause a severe hardship to these families. These land parcels, however, could function in a dual-public serving capacity. Outdoor recreation facilities might be established on the top of the site where feasible and desirable. The reestablishment of 828 residences in the Denver metro area could represent a significant positive impact to the building industry.

The large quantities of energy required for pumping is a significant impact. Exact amounts are not quantifiable for this model reservoir. Certain of the storage sites could potentially empty or fill on a gravity-flow basis but would still require pumping either to fill or to empty.

The construction of these sites and other necessary appurtenances would represent a very significant economic impact to the metro area construction industry. No detailed data are available as to the exact number of workers or time required to construct a water storage site with necessary appurtenances.

An impact would occur on streets where new conduits are to be constructed. Specifics of these impacts are not quantifiable.

The additional 72 personnel necessary for operation and maintenance of these sites would represent an insignificant impact on metro area employment between 2000 and 2010.

As stated earlier, to maintain the potable quality would require a booster chlorination station in all of the reservoirs. To supply these stations with chlorine would subject residential neighborhoods to increased risk from an accidental spill of chlorine due to increased exposure. The haul to these reservoirs would have a far greater risk factor than the existing hauls to three DWB treatment plants.

Conservation Education

The Denver Water Board currently utilizes several public education methods dealing with water conservation, including slide shows, films, handbooks, and a public information specialist.

Further activities would be undertaken by the Denver Water Board to educate the Denver public. These would include publicizing water conservation more extensively through television and radio advertising; using additional animated films and other media for educating children; setting up testing plots for types of landscape vegetation; exhibiting water consumption of various plant species; publicizing results of tests and encouraging the public to visit testing sites; using types of vegetation in DWB facilities which exemplify water conservation; testing sprinkler systems and appliances for efficiency; disseminating bumper stickers and billboards; and providing home and industry consultants to analyze the ways in which consumption may be reduced for more efficient, conservation-oriented homes and businesses. Costs and water savings attributable to this expanded level of public education are not quantifiable at this time; however the extent to which other conservation measures are effective is directly related to the success of a conservation education program. The awareness of lawn watering needs, the knowledge of ways in which household fixtures and appliances may be efficiently used, and the acceptance of the need to modify demand could be beneficial impacts of such a program.

A major impact of extensive conservation education could be a change in attitudes and values of consumers about this limited resource. This could manifest itself in an awareness and sensitivity toward the finite nature of other limited resources.

Beneficial employment impacts could occur in sectors related to advertising, public relations, and production of mass media information.

Dual Systems Application

Currently one third of the institutional consumption of water in the city is distributed untreated. This untreated water supply is used to irrigate parks, golf courses, other types of institutional horticulture, and run power plants. There are no known planned or proposed developments which would be utilizing raw water, delivered in a separate system, for institutional uses. It is conceivably possible that future developments of an institutional type (parks, golf courses, power plants, and others) could utilize a dual system. However many limitations exist in the application of a dual system. Intermixing treated water and raw water piping systems underground in transportation corridors through the metro area could potentially lead to accidental mixing and thereby pose a health hazard. In addition

the development of a separate piping system through the metro area redisturbing and disrupting transportation corridors may cause many related negative social impacts.

At the present, no new treated-water savings may be attributed to this element of this conservation alternative. Metro developers should be encouraged to look at this approach whenever feasible to assist in the conservation of water.

Amendments to Building Codes

Building codes relating to water use would be amended to require that all new construction and all reconstruction be conducted in a manner in which water-saving devices and techniques were optimally incorporated.

In a study prepared by the Denver Research Institute (1977), various devices which modify use of water were enumerated, and a "typical consensus" or savings in gallons of water was shown. (Savings enumerated are "consensus" savings.) A washwater recycle system can save 11.6 gdc; various toilet adaptations can save up to 4 gallons per flush; faucet flow controls, 1 gallon; shower flow inserts, 7.5 gallons per shower; and thermostatic mixing valves, 2 gdc. (Many of these can be retrofitted, to save water on already constructed buildings.)

Regulations regarding the installation of water saving devices, and the designing of systems conducive to a lower total water demand could have many impacts. Total water savings are not quantifiable at this time.

Increased expenditures would occur initially in the building industry, an impact primarily resulting from the conversions of design, construction, and production of these modifications. These costs could be passed directly to consumers. There would result a beneficial employment impact among sectors designing, producing, and marketing water-saving devices. There would also occur a beneficial employment impact from the need to plan, engineer, and develop sewage systems compatible with the lower quantity of water. There would occur a negative employment impact among the sectors producing appliances and systems which are not efficient in use of water.

Rationing Application

As a compulsory conservation measure, rationing would act to insure that total demand did not exceed total treatment and delivery capacity of the system. The extent to which it would be employed is a function of the success of other conservation measures. (Application could occur in a manner comparable to the summer of 1977.)

There are several impacts associated with rationing. A primary impact would be the loss of consumer choice in the allocation of this resource. This, in itself, could be a positive or negative impact, depending on the value placed by the consumer on decision-making. There would occur a negative impact among some consumers, as an externally-determined amount of water might not prove sufficient for all landscape types. This would result in a visual impact and a potential loss of horticultural investments for these consumers. A negative impact could occur if consumers did not perceive rationing as permanent and thus not adjust their consumption patterns in a manner conducive to long-term conservation of water. The need for consumers to arrange personal schedules in order to water their lawns would be a negative social impact.

Positive impacts occur with the high degree of effectiveness of this conservation measure, as epitomized in the summer of 1977 when demand was reduced by an average of 28 to 29 percent for the four-month peak use period. This measure would eliminate a great deal of overwatering. Landscape specialists have indicated that many lawns were healthier in the summer of 1977 with the regular watering imposed by rationing. This measure has a beneficial impact as it ensures that basic (domestic, in-house) needs would be met during peak periods.

Increased administrative and enforcement needs would result in a positive employment benefit.

Summary

As the capacity to meet max-day demands is a major criterion in the proposed Foothills Project, it follows that an alternative should address the measures necessary to remain within existing max-day treatment capacity.

The impacts associated with each individual measure (see previous discussion) would occur at the time when their implementation was deemed necessary to achieve desired reductions. Table 8-2 is a scenario reflecting one possibility for enacting these measures.

The primary impact of these measures, ultimately, would be horticultural. It is theorized that domestic in-house use tends to be quite uniform throughout the year (Green 1972). Initial savings occur in-house with the repair of leaky fixtures and installation of water-saving devices, but there is a long-run reluctance or inability of consumers to change the quantity of water demanded in their household uses.

TABLE 8-2

PERCENTAGE OF CONSERVATION EFFECTIVENESS AT EXISTING TREATMENT CAPACITY (MAX-DAY CONSUMPTION)

Projected Year	Metering	Pricing	Conservation Education	Rationing	Storage	Percent Reduction Obtained
1980	0	0	3	0	0	0
1985	6	9	0	0	0	15
1990	6	12	0	7	0	25
2000	6	12	0	24	1	43
2010	6	12	0	32	4	54

As previously stated, up to 20 percent of horticultural use may represent overwatering of lawns and gardens. Significant visual impacts, as well as extensive conversion to landscape types adapted to an arid-environment, would not begin to occur until overwatering was eliminated and basic watering needs were reduced. In the above scenario, this would not occur until an undeterminant time between 1985 and 1990.

The consumers' willingness to adjust the quality of water demanded for irrigation purposes does appear to be responsive to the introduction of price. According to Flack (1974),

> Under flat rate pricing there is no economic incentive to save water, and the tendency of most users is to assume green lawns by over irrigation.... Under metering householders are more likely to reduce their lawn watering to approximate the consumptive use requirements not met by rainfall.

While it may be assumed that homeowners view their landscaping as an investment and would be hesitant to cut consumption on particularly

hot dry days, this alternative would allow the governing utility to encourage lower consumption, modifying demand through several possible methods on peak days so as not to overextend the system's capacities.

Horticultural uses of water can be reduced greatly by preliminary preparation and planning; e.g., planning landscaping that will conserve water by reducing runoff through proper grading of lawns, designing irrigation systems to allow for maximum water absorption into the soil, and preparing the soil properly before planting to allow for deeper penetration of roots. An additional savings could be realized by reducing waste on existing lawns and landscaping.

The Department of Agriculture has tested water absorption rates of heavy clay soil and found that there is a maximum absorption rate of .2 inch per hour on a relatively flat slope. On a 12 percent slope, absorption is .1 inch per hour. Proper planning of lawns could reduce waste runoff of water. Soil preparation with organic material and in some instances sawdust can act to conserve water.

Homes could reduce lawn sizes, converting to shrub beds and ground covers in order to more efficiently use water.

It has been estimated that shrubs and ground covers take one half the amount of water as a typical lawn. Buffalo grass, when planted properly as a substitute for blue grass, needs approximately one-seventh as much water as blue grass. Alternative styles of landscaping, with species of plants that need less water, could be adopted by consumers.

The use of irrigation systems that are efficient in their distribution of water could expedite conservation greatly. Drip irrigation is highly efficient, particularly in shrub bed planting, and has the added benefit of reducing weeds. Large impulse rotorheads are generally found to be quite efficient in sprinkling large areas, as they slowly apply large drops of water for maximum absorption with a minimal loss to evapotranspiration. There are other innovative and efficient irrigation systems, one of which has resulted in savings of 8 percent in the hottest summer months and 48 percent in the cooler months (personal communication, Frankheuser 1977).

Pressure regulating valves on all sprinkling systems could conserve water as well as aid in rationing in times of emergency. The reductions in quantity demanded which occur to achieve this alternative are presented in Table 8-3.

The cumulative impacts of this alternative would be greatest in the year 2010, when the projected quantity demanded would be reduced 54 percent. Significant impacts would be occurring as secondary results of the primary horticultural impact. As the water resource, water increases in scarcity, the substitutions for its use will

increase. Demand for public recreation areas or neighborhood "green belts" would increase. Demand for the services and supplies of sectors related to the horticultural adaptions would occur, with increased employment and increased expenditures by consumers. Changes in land use patterns could ultimately occur, with smaller lot sizes and fewer single family dwellings.

The reductions in quantity demand which would occur to achieve the alternative presented in Table 8-2 are as follows:

TABLE 8-3

PERCENTAGE REDUCTION ACHIEVED IN MAX DAY WATER CONSUMPTION
1980-2010
(WITHOUT PROJECT)

	Projected 1/ Max-Day Demand GDC	Projected 2/ Available Supply GDC	Shortage GDC	Percent Reduction Necessary
1980	614	598	16	3
1985	636	542	94	15
1990	656	493	163	25
2000	699	400	299	43
2010	742	338	404	54

1/ Table 1-4, Foothills FES

2/ Table 8-5, Foothills FES

No Action Alternative

Description

Under the No Action alternative, the Bureau of Land Management (BLM) and the U. S. Forest Service (USFS) would deny the right-of-way application for construction of the Strontia Springs diversion dam and reservoir, tunnel, and access road improvements.

Analysis

A rejection of the Denver Water Board's (DWB's) right-of-way applications would restrict expansions of its raw water diversion facilities in Waterton Canyon. As a result, it is assumed that the proposed Foothills treatment facilities and treated-water conduits, as described in the Proposed Action, Chapter 1, would not be constructed.

Pertinent to discussion of no action in the following sections, it is emphasized that impacts directly attributable to the non-quality of treated water, which the project would otherwise provide, would be very difficult to define. Water is only one among a variety of interacting forces that shape land use. Other forces include topography and soil types, transportation, utilities (communications, electricity and sewage), education and social services systems.

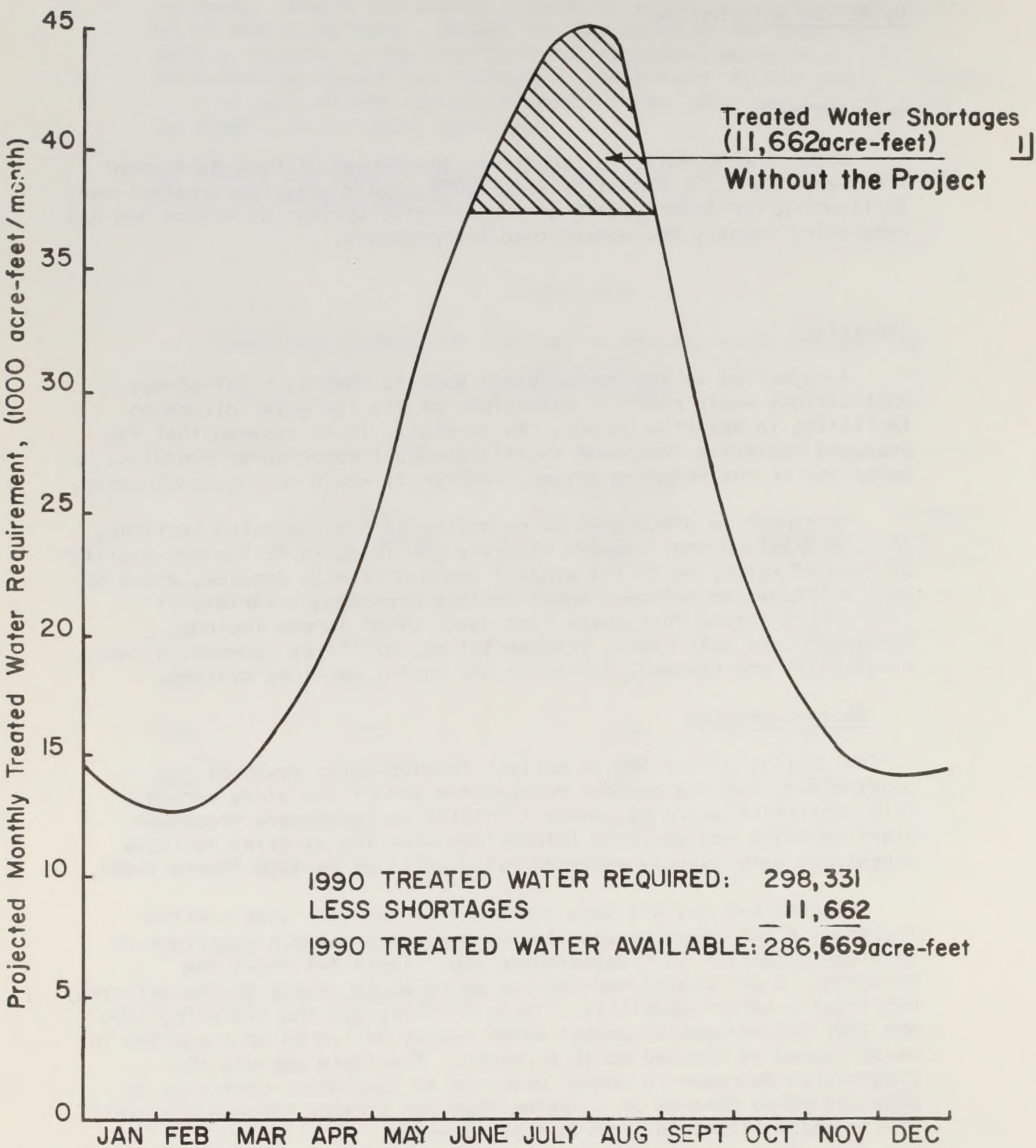
Socio-Economics

The ability of the DWB to deliver treated water would be constrained from the present through the end of the study period. This constraint would be caused initially by inadequate treatment plant capacity and would be intensified when the existing reliable annual raw water supply would be fully utilized in 1990 (Table 2-28).

Figures 8-2 and 8-3 show that part of the year when limited treatment plant capacity and limited raw water would necessitate an absolute reduction in treated-water use. Table 8-4 shows the reduction in per capita max-day use as it would relate to the existing DWB treated-water capability. Table 8-5 displays the historic, 1990 and 2001 percentages of annual water supply delivered or projected to be delivered by the DWB month by month. The table depicts the progressive decrease in summer peak-use as population continues to grow and makes demands on a system that has already reached the limit of its capabilities to provide treated water.

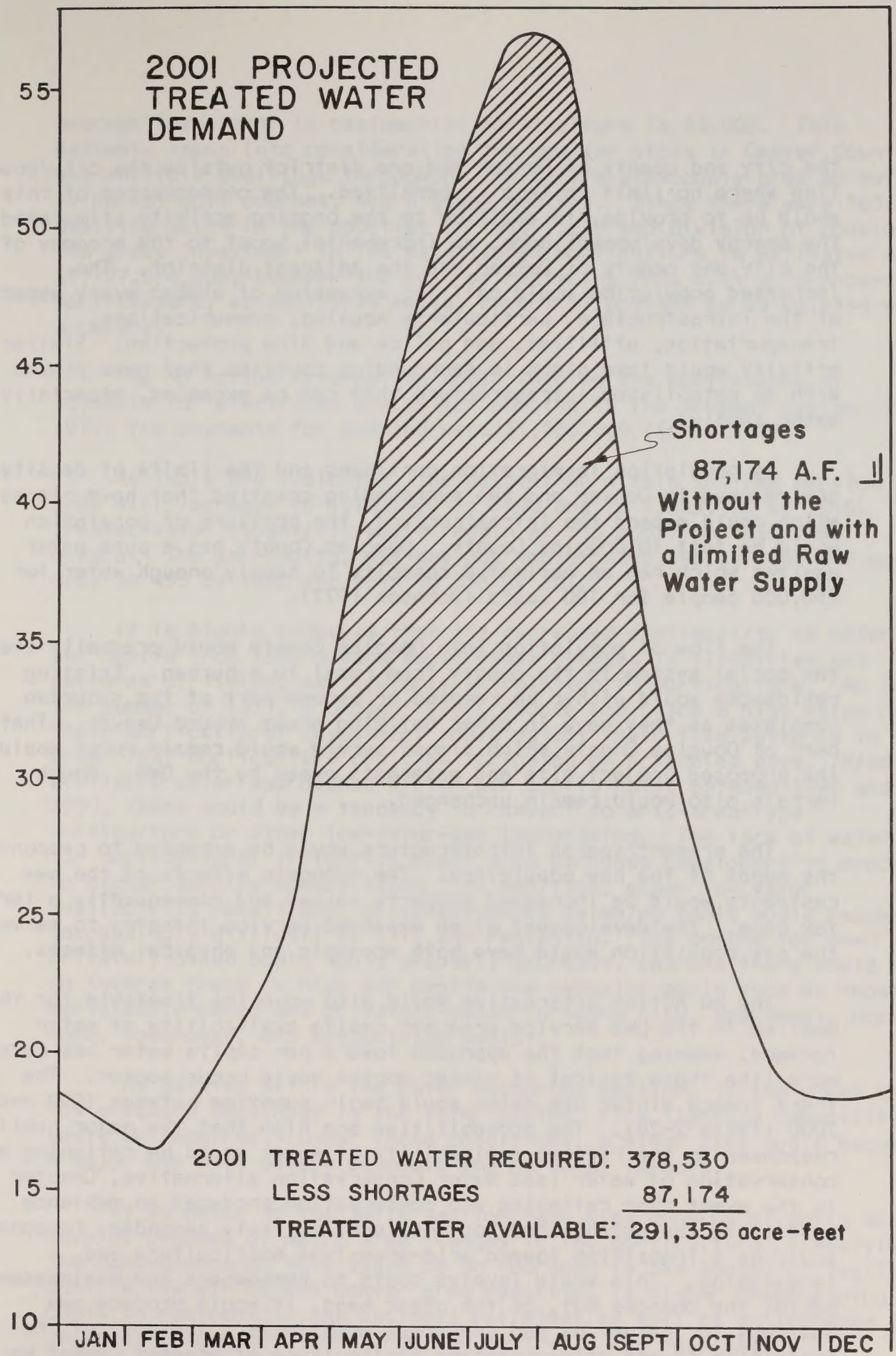
As noted in Chapter 2 in the Future Without the Project, the No Action alternative would tend to increase the population density in

1990 PROJECTED TREATED WATER DEMAND



1/ Shortages predicated upon inability to satisfy treated water demand.

FIGURE 8-2



1/ Shortages predicted upon inability to satisfy treated water demand

FIGURE 8-3

the city and county of Denver and one district outside the city/county line where no limit on taps is permitted. The consequences of this would be to provide, in addition to the ongoing activity stimulated by the energy development boom, an incremental boost to the economy of the city and county of Denver and the adjacent district. The increased population would call for expansion of almost every aspect of the infrastructure, particularly housing, communications, transportation, utilities, and police and fire protection. Similar activity would take place in surrounding counties that have places with an established infrastructure that can be expanded, especially water supply.

As population in-migration continues and the limits of density are reached in Denver and the surrounding counties that have places which could expand the infrastructure, the pressure of population would be felt in Douglas County. Douglas County has a pure water aquifer which has an estimated capacity to supply enough water for 250,000 people for 100 years (Johnson 1977).

The flow of population into Douglas County would gradually change the social system in the county from rural to suburban. Existing residences would either be removed or become part of the suburban complexes as they have in other outlying areas around Denver. That part of Douglas County which almost surely would remain rural would be the proposed project site and easements owned by the DWB. Rough terrain also would remain unchanged.

The present sparse infrastructure would be expanded to respond to the needs of the new population. The economic effects of the new residents would be increased property values and consequently a larger tax base. The development of an expanded service industry to serve the new population would have both economic and physical effects.

The No Action alternative would also move the timetable for the decline in the DWB service area per capita availability of water forward, meaning that the approach toward per capita water use rates more like those typical of winter months would occur sooner. The trend toward winter use rates would begin sometime between 1990 and 2000 (Table 2-28). The probabilities are high that the major public responses to the reduced availability of water would be rationing and conservation of water (see Water Conservation alternative, Chapter 8). In the event that rationing and conservation produced an ambience hostile to the established horticulture, a likely secondary response would be a transition toward arid-area-type horticulture and landscaping. This would involve costs to homeowners and businessmen making the changes but, on the other hand, it would produce new business for nurseries and landscape architects. The cost of the transition toward arid-area-type horticulture at present cannot be calculated with any great accuracy since the degree of transition is unknown. It has been estimated conservatively that the present

average investment in residential horticulture is $2,000. This estimate takes into consideration the smaller plots in Denver County and multiple dwellings throughout the entire six-county area as well as parks, golf courses, and highway medians. Since there were 563,837 dwelling units in the counties in 1975 (Colorado Division of Housing), the gross investment in the established horticulture is estimated at $1,127,674,000; however the cost of replacing this with arid-area-type horticulture, as mentioned above, cannot at present be calculated with accuracy.

The No Action Alternative would involve the continuance of payments for electrical energy for pumping in the present system; in 1977, the payments for pumping were $1,160,000 (Tolle 1977).

As Table 8-4 indicates, the population within the DWB service area will increase to 1,162,900 in 1990 and to 1,693,700 by 2010. The treated-water capability would remain at 573 mgd from that time onward. The per-capita, max-day gdc would reach 598 by 1980 and would drop to 493 by 1990 and then to 338 by 2010.

It is highly probable that the decreased availability of water per capita from 1980 onward would cause changes in lifestyles and patterns of living, particularly in relation to horticulture. As in the summer of 1977, a drought year, people who place a high value on their horticultural investment would adjust their life patterns in order that horticulture could be irrigated on scheduled days. Also as available water approached winter per capita rates betweem 1990 and 2000, there would be a tendency to convert to arid-area-type horticulture or other low-water-use landscaping. The lack of water for horticultural irrigation might also persuade developers to proceed to higher density homebuilding. In addition, under low water availability conditions, privately-owned swimming pools would become increasingly difficult to fill and replenish. The demand for new privately-owned pools would probably decrease, whereas there would be an inverse trend in high per capita use swimming pools such as those municipally-owned and privately-owned (private club, apartment, mobile home, townhouse, and condominium pools).

As pointed out in the Water Resources section, in the event that low pressure developed in the water system, fire fighting capability would be impaired. Under these conditions, a minor fire could become a major one with severe economic and personal impacts.

It is noted in the Soils section that wind erosion of soils would develop because of metro area changes in the horticultural lifestyle. The consequence of this would be an increase in the amount of fugitive dust in the air in the Denver area resulting in higher housekeeping costs in residential and business buildings as well as an increase in personal discomfort, both from the aesthetic and respiratory points-of-view.

TABLE 8-4

PER CAPITA-MAX-DAY USE DURING PEAK-USE PERIOD OF YEAR

Year	Population	Treated Water Capacity mgd 1/	Per-Capita Max-Day gdc 2/
1971	792,000		578
1972	812,000		551
1973	833,000		608
1974	879,000		551
1975	891,000		561
1980	958,400	573	598
1985	1,057,200	573	542
1990	1,162,900	573	493 3/
2000	1,434,100	573	400 3/
2010	1,693,700	573	338 3/

Source: DWB Annual Reports

1/ These figures include a total capacity of 264 million gallons of treated water storage assumed available over a 5-day period (53 mgd) (DWB, 1973).
2/ Gallons per day per capita.
3/ Assumes no raw water supply limitations.

Water Resources

As discussed in Chapter 2, under Future Environment Without the Proposed Action, as population increased within the DWB service area, the annual water demand would increase until it equaled the reliable annual raw water supply of 312,300 acre-feet. The presently unused supply of the South Platte and Roberts Tunnel Systems after losses has been determined to be 79,100 acre-feet. As this water is used, average annual flows in the South Platte River watershed would continue to increase until about 1990. Without additional raw water supplies, average annual flows would not increase after 1990. Projected average annual flows and average monthly flows at a number of locations in the South Platte River watershed are shown in Tables 2-29 and 2-30, respectively. Comparison of the discharge data presented in Table 2-29 and Table 2-30 shows increases in the flow of the North Fork of the South Platte River at Grant during every month of the year. These increases range from 6 percent in June to 409 percent in February. The increased discharge could increase bank erosion on the lower 20 miles of the North Fork of the South Platte River where there is no channel stabilization.

Average drawdown of Dillon Reservoir during the period from 1966 to 1973 was 10.2 feet, reducing the water surface area an average of about 394 acres. With the increased diversions from Dillon Reservoir through the Roberts Tunnel, the annual drawdown would approach an average of 42 feet, and drawdown would be greater during those periods of years with below-normal streamflow. Such an average drawdown would reduce the surface water area by about 1,270 acres. Generally, the lowest level would occur during the winter and early spring each year, when the reservoir is drawn down to make room for the anticipated snowmelt runoff.

Average annual flows downstream of Dillon Dam would be reduced by the amount of the increased diversions through Roberts Tunnel. When full use of the annual reliable raw water supply is reached, this reduction would average an estimated 83,300 acre-feet per year.

The resulting 83,300 acre-foot reduction of flow in the Colorado River watershed would remove 11,300 tons of dissolved solids from the basin and increase the salinity concentration of Colorado River water at Cameo, Colorado, by about 11 mg/l and at Imperial Dam, Arizona, by about 7 mg/l.

To minimize overtaxing the treated-water system, water use restrictions would be mandatory. Such restrictions would be implemented early in the spring and continue through the fall. Overtaxing the system could cause low pressure to develop, possibly resulting in the loss of fire-fighting capability and contamination within the treated-water transmission system.

TABLE 8-5

PROJECTED MONTHLY PERCENTAGE OF THE ANNUAL WATER SUPPLY DELIVERED BY THE DWB

Months	Historic Average 1964-1973	W/o Project 1990 1/	W/o Project 2001 1/
January	4.7	4.9	6.1
February	4.3	4.5	5.7
March	5.3	5.5	6.9
April	6.8	7.1	8.8
May	10.4	10.8	10.2
June	12.9	13.4	10.2
July	14.9	13.4	10.2
August	14.6	13.4	10.2
September	9.6	9.9	10.2
October	6.7	6.9	8.7
November	5.0	5.2	6.6
December	4.8	5.0	6.2

1/ Raw water supply available limited to existing supply (312,300 acre-feet).

Without the project, a "blue line" zone similar to the one in effect from 1951 to 1957 could possibly go back into effect. At that time, the DWB would not supply water beyond a geographical zone (called blue line zone) because of an insufficient amount of water available to service customers outside a certain area. This blue line zone could adversely affect the Douglas County aquifer by the additional developmental needs, potentially reducing that aquifer over a 100-year period.

The blue line zone could also adversely affect all 22 water delivery systems in the Denver area by creating a more intense need to develop new sources of water. The aquifers would probably be tapped to the maximum allowable under Colorado water law, creating a long-range commitment of those resources of water. This law states that 1 percent of the aquifer may be used if annual water buildup in the aquifer is equivalent to 1 percent of the aquifer. In addition, the existing water rights of agri-business could potentially be condemned by these 22 systems or newly-developed systems (Anderson, 1976).

Aquatic Resources

An increase in use of ground water could decrease the amount of water entering local streams. A lesser amount of water in the streams would lower the water quality, thereby adversely affecting the aquatic resources. Conversion from agriculture to urban land uses would impact local streams by lowering the quantity and quality of water. Aquatic resources in the Waterton Canyon area are not expected to change, however.

Drawdown of Dillon Reservoir would affect aquatic resources by reducing the amount of biomass in the reservoir.

Geology, Minerals, and Topography

The future environment would not differ greatly from the present environment.

Soils

Increased wind erosion of soils would develop to an undeterminable degree because of metro area change in horticultural lifestyle to an undeterminable degree.

Although use of ground water would be increased, there would be no impact upon soils within the project area.

Climate and Air Quality

Fugitive dust would affect the distance that one could see and could cause a hazardous situation. A large amount of fugitive dust could increase property maintenance costs. Fugitive dust would have a negative impact on visual resources.

Terrestrial Resources

Impacts of the No Action alternative upon terrestrial ecosystems would be caused by a change in location of urban development, increased development of ground water, and loss of agriculture water.

Recreation Resources

A change in location of urban development would impact recreation resources by making less land available for recreational facilities. Also, it would place greater demand on those facilities and subject them to more usage and vandalism.

The quality of fishing would be affected and the amount of boating would be limited as a result of increased flows into the South Platte River System.

Channelization projects to handle increased flows would have an adverse impact upon aquatic life and water quality and the quality of fishing. Large water flow volumes would impact the safety of fishermen and boaters.

Dillon Reservoir would be impacted by increased drawdowns.

Visual Resources

A change in the location of land development would affect the visual resources of the Denver area. A marked increase in airborne particulate matter (fugitive dust) would reduce the aesthetic qualities of the vegetation thereby adversely affecting the visual resources.

Cultural Resources

The future environment would not differ greatly from the present environment.

Land Use

In future land use, this alternative is nearly identical to Chapter 2, Future Without the Project. Maps 2-15, 2-16, and 2-17 at the end of Chapter 2 show expected land uses. Review of current (mid-1977) information cited in Chapter 2 indicates that

well-established infrastructures, both within and outside of the DWB service area, largely independent of the presence or absence of the project, set the direction for land use and development. During the Foothills DES public hearings, Donald DeDecker testified that it is DRCOG's belief that water is only one of many factors involved in growth and responsible planning done by DRCOG (DRCOG 1977).

It is likely that DWB would maintain ownership of all the lands or easements it has acquired for the project. The rough topography at the dam site would not likely be converted to land uses different from those which presently exist. Nondevelopment at the proposed treatment plant site would allow continuation of existing uses (grazing and open space) but it could also create an enclave around which developments would have to be planned at the expense of long-term good land use design. Conduit No. 27 would not be installed, so there would be no short-term project-related surface disturbance; however DWB's right-of-way for the conduit would create a potential linear area (Figure 2-7) of nondevelopment aggregating 125 acres. While this could interfere with urban and suburban design for optimum land use, which would very likely occur at numerous locations along the conduit route from the treatment plant site northeasterly to South Colorado Boulevard, this nondevelopment probably could equally well be integrated into good land use planning by using it as open space.

Potentially favorable land use impacts under No Action could be maintenance of a lesser amount of available treated water that might to some extent inhibit urban sprawl and help to achieve development of presently underdeveloped lands within the DWB service area. This in turn could reduce or forestall intrusion onto bedrock or alluvial aquifers, conversion of agricultural lands to urban uses, reduction in urban and suburban lot sizes, increased construction of multiple dwelling units, reduction in areas covered with water impervious cover (streets, etc.), concentration of people into densities amenable to more economical public transportation with attendant reduction in dependence on the automobile and reduced air pollution.

In summary there would be a trend toward a higher density of population in the city and county of Denver. The next most active area would occur where the DWB service area and other infrastructures are established.

Development or extension of infrastructures into the presently undeveloped area of adjoining counties, including Douglas County, would proceed more slowly.

MINOR ALTERNATIVES

Lower Dam

Description

A lower dam that would serve as an adequate diversion structure could be constructed at the Strontia Springs site. The lower dam would rise to 168 feet above the streambed with a crest length of 510 feet and would vary in thickness from 150 feet at its base to 40 feet at its crest. It would create a reservoir with a capacity of 2,400 acre-feet and a surface area of 50 acres that would extend 7,800 feet upstream. The reservoir would have a dead storage pool of 600 acre-feet that would accumulate silt for about 30 years before dredging would be necessary. Diversion of the river prior to construction of the dam would be the same as described for the proposal, requiring upstream and downstream cofferdams and the same 18-foot diameter diversion tunnel. At least 130,000 cubic yards of rock material would have to be excavated for the dam. Construction material for the dam (222,170 cubic yards of concrete) would be from the same source as that in the proposal. The service spillway of the dam would be located in the center so that only a small amount of excavation of the canyon walls would be needed. During extreme flood conditions, water would flow over the entire length of the dam crest. Just downstream of the dam, a plunge pool 90 feet wide and 25 feet deep would be excavated across the entire canyon bottom.

The river outlet works, the intake system, tunnels, treatment plant, conduits, roads, staging areas, and powerlines would be the same as those described for the proposal. Construction time and the number of employees would be the same as those for the proposal. No energy production would occur with this alternative.

Winter icing conditions would cause this diversion structure to be operative for only seven months of the year and would necessarily change the Foothills Treatment Plant operating strategy. Special measures would be required to assure that the tunnel system would not become blocked with a silt load as has been experienced in the past with the Aurora System.

Analysis

The impacts of the lower dam and reservoir would be basically the same as for the proposed dam and reservoir except that the magnitude of each would generally be smaller.

Elevator Access to the Dam Crest

Description

Instead of a road from Stevens Gulch to the right abutment, an elevator, installed adjacent to the dam, could be used to move operations and maintenance equipment from the floor of the canyon to the dam crest. Foot access to the dam crest would be through the inspection gallery in the dam.

Analysis

The construction of the elevator access would not have identifiable impacts on the environment. However, it would eliminate the need for about 3,000 feet of new road construction through steep, rocky, mountainous terrain. Massive sidehill cuts would be eliminated, and the total amount of sediment yield would be reduced by 30 tons during the construction and reclamation period. About 4 acres of forested habitat (montane forest) that would have been destroyed by the proposed road to the dam crest would not be disturbed. This would eliminate aesthetic damage to the canyon walls and thus reduce visual impacts on recreational values.

Fourteen-Foot Standard Road With Turnouts

Description

Reduction of the width of all proposed 22-foot road widening to a maximum of a 14-foot standard width with turnouts and filling on the river side, with minimal cutting into the canyon walls, would be carried out. This would include 16,400 feet of ground surface roadway.

Analysis

The reduction of this roadway to a maximum of 14-foot standard width with turnouts would significantly affect the safety and utility of the road. Traffic of passenger vehicles and construction equipment, i.e., large earthmovers, dump trucks, concrete mixer trucks, and buses, would be on a slow two-way basis utilizing turnouts for passing when necessary. This standard of road would pose sight-distance hazards to drivers and would increase the number of accidents.

Parallel Bridge to the Keystone Bridge

Description

Instead of removing the historic Keystone Railroad Bridge and building a new vehicular bridge across the South Platte River in the Waterton Canyon as part of the access road construction, a parallel bridge could be built downstream. The Keystone Bridge would then be used for nonvehicular traffic (hikers, bikers, etc.) and as an historic interpretive object, with displays of the historic resources within the Waterton Canyon.

Analysis

The construction of the second bridge slightly downstream of the present railroad bridge would have certain environmental impacts. The second bridge would necessitate the construction of new abutments at the stream edge and new center supports in the stream itself. These would impact aquatic resources and yield sediment to an unquantifiable degree. A sidehill cut, impacting visual resources to an unquantifiable degree, would be needed to achieve adequate right-of-way for the parallel bridge. This minor alternative would preserve the historic resource and setting to a much higher degree than would the removal of the bridge.

Underground Powerlines and Telephone Lines

Description

Powerlines and telephone lines could be buried in or adjacent to roads as they are being constructed or upgraded. From the Platte Canyon Intake to Stevens Gulch, 2.8 miles of 13.2-kilovolt powerlines and telephone lines would be buried during road improvement. During construction of roads in the treatment plant area, 2,000 feet of 1.26-kilovolt powerlines and telephone lines would be buried in the new road.

Analysis

Since the underground powerlines would not be visible, the adverse impacts related to aesthetics and recreation on about 3.2 miles of aerial powerlines would be eliminated. Of course, portions of the line potentially could be buried. The potential for electrocution of raptors and inflight collisions with conductors would also be eliminated. However, this minor alternative would cost approximately $700 thousand to implement and would have some operational and maintenance drawbacks, i.e., in the event a breakdown occurred in the line, the main access road would have to be dug along the buried line to find the break.

ALTERNATE NEW SOURCES OF RAW WATER

Introduction

General

The Department of Interior directed that redraft of the Foothills Draft Environmental Statement include a discussion of new sources of raw water needed to meet the 500 mgd capacity of the Foothills Treatment Plant. A letter dated November 1, 1976, from Jack Horton, Assistant Secretary of the Department of the Interior, Land and Water Resources, stated--

> The subject document should also be expanded to identify and assess the enviromental impacts associated with the various alternative sources of water supply, storage, and transmission, including transmountain diversion if necessary, that could reasonably be expected to meet the 500-mgd capacity of the Foothills treatment plant. The discussion of alternative sources of water supply and storage facilities should include:
>
> a) the Chatfield Reservoir;
> b) enlargement of Gross Reservoir;
> c) extension of the Williams Fork collection system;
> d) transfer to South Platte and Bear Creek ditch rights;
> e) exchange of transmountain effluent;
> f) the proposed Two Forks project.
>
> Because specific supply sources or systems have not been proposed at this time, these alternatives should be treated generally as to their adequacy in terms of single units, or in combination to supply the 500 mgd Foothills treatment operation. It should also be stated that a future site-specific environmental assessment will be required for any eventual decision and action that is related to the development of these alternative water supplies.

Based on this clear directive, a memorandum of understanding was written to Bureau of Land Management from Bureau of Reclamation stating--

> It is our intention to discuss those alternatives which can reasonably be expected to enable the

> Denver Water Board to have waters available for treatment at a Foothills plant with a capacity of 500 mgd. The facilities associated with such alternatives may include storage and collection systems on the West Slope, East slope storage necessary to regulate transmountain diversions and/or waters obtained through acquisition of agricultural water rights.
>
> There will be no attempt to show engineering feasibility or economic justification for any of the water supply alternatives. The discussion of water supply alternatives will be limited to a few (two or three) most reasonable methods of meeting the 500 mgd requirements for the Foothills plant. Reclamation will furnish complete writeups on each . . .

In addition, in the approved Environmental Statement Preparation Plan for the Foothills Project (February 8, 1977) a directive is provided for the method of inclusion of this material. It states--

> . . . the revised DES will identify and assess, in a special section of the Alternatives chapter, the general environmental impacts associated with developing alternative additional sources of raw water supply . . .

This section discusses alternative new sources of raw water supplies and three possible concepts to provide raw water supplies to the Denver Water Board's (DWB's) Denver metropolitan service for municipal and industrial use. In describing these concepts or scenarios, the detail is less than appraisal level, and the discussions on features, operations and corresponding environmental impacts of the three concepts are covered in a general manner.

Although there may be any number of other combinations of existing and potential features which could be utilized to develop the required raw water supplies, the three concepts presented here were determined to be representative of alternative new sources of raw water supplies for treatment by the potential Foothills Project.

These potential concepts and their individual features would require a complete and detailed environmental analysis under NEPA (1969) and the preparation of specific environmental statements.

Likewise, during the detailed investigation of potential features, historic and cultural resources would be inventoried by qualified personnel as required by Executive Order (E.O.) 11593. Determinations of eligibility of <u>National Register of Historic Places</u>

would be made, and Advisory Council on Historic Preservation would be afforded an opportunity to review resources in accordance with Regulations of Advisory Council on Historic Preservation--Protection of Properties on the National Register; Procedures for Compliance. Other legislation requiring compliance include the 1906 Antiquities Act, the 1935 Historic Sites Act, E.O. 11593, and the 1974 Historical and Archaeological Data Preservation Act. In addition, any proposal for development must comply with all applicable federal regulations, including the following:

1. Noise Control Act of 1972 (Public Law 92-574).

2. Federal Water Pollution Control Act (Public Law 84-660) as amended by Public Law 92-500 in 1972.

3. Clean Air Act of 1970 (as amended by Public Law 91-604).

4. Reservoir Salvage Act of 1960 (Public Law 86-523) as amended in 1974.

5. Endangered Species Act of 1973 (Public Law 93-205).

6. Executive Order 11953 (Protection and Enhancement of the Cultural Environment).

7. Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646).

8. Fish and Wildlife Coordination Act of 1958.

Criteria for Water Supply Concepts

It was concluded that the water supply concepts would include combinations of the following potential features or actions: enlargement of the existing Gross Reservoir and expansion of the Williams Fork collection facilities of the DWB's existing transmountain Moffat System; enlargement and use of the Corps of Engineers' existing Chatfield Dam and Reservoir; construction of the potential Two Forks Dam and Reservoir on the South Platte River; development of the potential modified Eagle River collection system; development of additional Blue River collection facilities; acquisition of additional water rights by the DWB in Bear Creek and the South Platte River; and exchange of treated sewage effluent from Denver for downstream agricultural water. The concepts also utilized existing collection, transmission, and storage facilities.

The concepts were formulated using data compiled on previous investigations, including that of private consulting firms, engineering reports, and environmental assessments on DWB proposed project features, and on Bureau of Reclamation and Corps of Engineers investigations and reports. Primary reference material is listed in the bibliography. No additional detailed studies were made on any potential features.

Each concept described was formulated to provide enough raw water to satisfy the annual raw- and treated-water demand of the DWB at the time the full Foothills Treatment Plant capacity of 500 mgd is projected to be required. This amounts to the existing 520 mgd treatment capacity, plus the future additional treatment capacity of 500 mgd, making a total of 1,020 mgd water treatment capacity available to the DWB service area.

Consideration of the legal, economic and detailed engineering and hydrologic aspects of the raw water supply concepts as presented was not a factor in the selection of the concepts. Such consideration will be necessary prior to any potential implementation.

The DWB has developed procedures using population projections, historic temperature and precipitation data, and historic water-use patterns to estimate the treated-water supply needed to meet maximum hourly, daily, and annual demands and to determine when 1,020 mgd treatment capacity (the system's capacity with Foothills implemented at 500 mgd) would be required. Historically, part of the developed raw water supply has been delivered untreated to DWB raw water contractors. Estimates of the raw water requirement at the time the additional 500 mgd would be needed are 378,500 acre-feet for treatment and 27,200 acre-feet for raw water delivery points. This 405,700 acre-feet was used as a target for all raw water supply concepts developed in this section.

The raw water supply concepts were formulated to combine existing and potential features, including Strontia Springs Dam, to provide for the collection, transmission, and regulatory storage of the raw water to meet the total treated and raw water requirements.

The water supply figures developed for each concept were not determined by actual operation studies but are considered to be within about 20 percent of the raw water demand. Minimum streamflow requirements, sewage effluent exchange criteria, and supplies derived from water rights acquired but not yet fully defined, may reduce the estimated water supplies in the concepts presented.

Concepts

Concept A

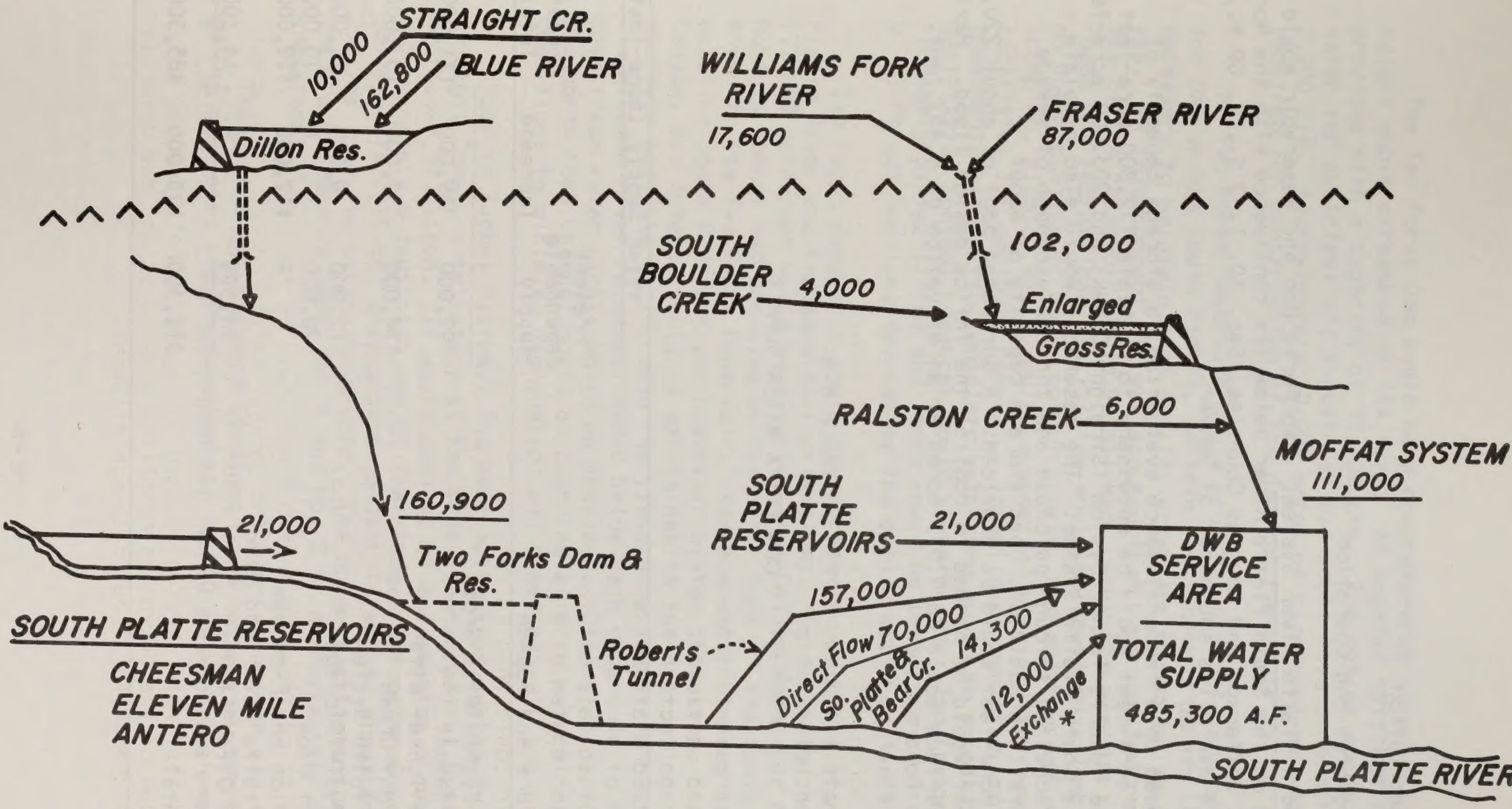
General

This concept, shown on Map 8-1, located at the end of this chapter, would permit the DWB to use more water from its west slope Moffat System, expand its west slope Roberts Tunnel System, and provide additional terminal storage facilities. It would also permit the DWB to acquire new water rights and exchange treated-Denver sewage effluent for agricultural water within its east slope South Platte River water supply system. From a structural standpoint, the concept would involve enlargement of the existing Gross Reservoir (Moffat), construction of the potential Two Forks Dam on Straight Creek to divert additional Blue River tributary water into Dillon Reservoir (for the Roberts Tunnel System). The combination of these features and operation modifications would provide a total of about 485,300 acre-feet of raw water for the Denver metropolitan area. Approximately 173,000 acre-feet of this would be new water provided under Concept A. Figure 8-4 and Table 8-6 show the amount of water provided by each feature and source.

Enlargement of Gross Reservoir would improve the overall operational efficiency of the west slope Moffat System which consists of water collection facilities on the upper tributaries of the Williams Fork and Fraser Rivers.

Another facet of the concept would be the construction of a collection system on Straight Creek whereby additional water could be collected and diverted to Dillon Reservoir. Water from Dillon Reservoir could then be conveyed through the Roberts Tunnel to the North Fork of the South Platte River where it would be stored and reregulated in the potential Two Forks Reservoir. When released for downstream requirements, it would be diverted by Strontia Springs Diversion Dam located about 3.5 miles downstream and then conveyed through a tunnel to the Foothills Treatment Plant and finally to the Denver metropolitan area for use.

The third facet of this concept would be the purchase by DWB of water rights presently used for agriculural purposes, which would permit the diversion of this water to the potential Foothills Treatment Plant for municipal and industrial use. In addition, it is proposed that water presently used for agricultural purposes downstream of the Denver metropolitan area be stored and diverted by DWB in exchange for treated sewage effluent.



*Exchange includes acquired water rights

NOTE: ALL NUMBERS IN ACRE-FEET

WATER SUPPLY SCHEMATIC

CONCEPT A

FIGURE 8-4 Rev. 5/13/77

Description

Features and Operation

South Platte River System. Two Forks Dam and Reservoir would be located on the South Platte River below its confluence with the North Fork in Jefferson and Douglas Counties, Sec. 30, T. 7 S., R. 69 W., about 24 air miles southwest of Denver.

Based on a reconnaissance evaluation, a storage capacity of 305,000 acre-feet would be necessary to regulate 172,800 acre-feet from the Roberts Tunnel System (Straight Creek) and 203,000 acre-feet from the South Platte System. The reservoir would also regulate waters acquired through purchase and through exchange of sewage effluents. In addition, dead storage capacity of about 25,000 acre-feet would be provided. A surcharge pool of about 220,000 acre-feet would be needed to control the inflow design flood. Maximum water surface would be 7,515 acres at an elevation of 6,457 feet.

TABLE 8-6

CONCEPT A WATER SUPPLY

	Water Supply (acre-feet)		
Feature and Source	Present dependable supply	Increase	Concept A Total
Moffat System with Gross enlargement	92,000	19,000	111,000
Roberts Tunnel with Straight Creek	124,000	33,000	157,000
South Platte System			
Reservoir Storage	12,000	9,000	21,000
Direct Flow	70,000	0	70,000
Aquisition and Exchange	-	112,000	112,000
South Platte River and Bear Creek Ditch rights	14,399	0	14,300
Total	312,300	173,000	485,300

The Two Forks Dam would be a concrete-arch structure with a height above streambed of 444 feet. An ungated spillway would be provided with a capacity of 32,400 cfs. The outlet works to release water for municipal and industrial use would have a capacity of about 5,200 cfs. Approximately 10,000 acres of rights-of-way would be required for construction of the dam and reservoir.

As Two Forks Reservoir would provide terminal regulatory storage for DWB on the South Platte, certain restrictions on its use would be necessary to maintain high quality water for municipal and industrial use. In this concept, it was assumed that very limited recreational use of the reservoir would be allowed. Only the minimum of access roads and recreational facilities would be provided. There would be no power-boating or body contact sports, and all recreation areas (camping, picnic, etc.) would be provided with vault-type toilet facilities for periodic removal. Insecticide and other chemical treatments within the immediate watershed would be prohibited. Strong anti-litter control measures would be enforced. Two Forks Reservoir recreational facilities and lands would be under the control of the U. S. Forest Service; day-use by the public could be limited.

Two Forks Reservoir would be operated to regulate the South Platte River and transmountain diversions. On an annual basis, 172,800 acre-feet would be diverted from Dillon Reservoir through the Roberts Tunnel and conveyed by the North Fork of the South Platte River to the Two Forks Reservoir. Maximum water storage in the existing South Platte River Reservoir System (Cheesman, Eleven Mile Canyon, and Antero) would be maintained in the highest reservoir whenever possible to increase the yield on a long-term basis. Only the minimum river releases needed below each reservoir to meet senior downstream water rights would be provided. Diversion of flows into the North Fork Channel would be coordinated with natural flow conditions to minimize degradation and flooding.

<u>Roberts Tunnel System</u>. The next collection system is located on Straight Creek, a tributary of the Blue River, about 1.5 miles northeast of Dillon. It would consist of a diversion structure approximately 6 feet high and 60 feet long. The water would be conveyed in a 75-cfs underground conduit 4 feet in diameter, about 2 miles long, to Dillon Reservoir. The conduit alignment would follow the old Oro Grande Canal No. 1 and No. 2 at approximately 9,300 feet elevation.

The system would divert Straight Creek waters primarily during spring and would yield approximately 10,000 acre-feet a year.

The average annual streamflow in Straight Creek below the diversion point for about 3.5 miles would be reduced by 14 cfs. The flow above the Straight Creek diversion has averaged about 16 cfs annually.

The flow in the Blue River from Straight Creek to Green Mountain Reservoir would also be reduced by an average of 56 cfs during the diversion period. The average flow in this 22-mile reach of the Blue River would range from 500 cfs near the junction with Straight Creek to 1,000 cfs at Green Mountain Reservoir during the diversion period.

The current operation of Dillon Reservoir would change when terminal storage at Two Forks Reservoir becomes available on the South Platte River. Water releases would be increased through the Roberts Tunnel into the North Fork of the South Platte during the summer, fall, and winter. These increased releases would cause the water level in Dillon Reservoir to decrease by an average of 74 feet. This would reduce the surface area from 3,233 acres to 1,416 acres. Spills from Dillon Reservoir, which normally occur in the early summer during wet years, would be decreased.

Moffat System. Gross Dam and Reservoir was completed in 1954 to store a total capacity of about 43,065 acre-feet. The potential enlargement would raise the height of this structure from 340 feet to 453 feet and increase the conservation capacity to 113,000 acre-feet.

The surface area of Gross Reservoir at maximum storage capacity is 432.1 acres; the surface area of the enlarged reservoir would be 803.5 acres. The present reservoir has a shoreline of 9.9 miles, while the enlarged reservoir would have 12.1 miles of shoreline and would inundate approximately an additional 3,000 feet of South Boulder Creek at the upper end of the reservoir. It is anticipated that the present limited recreational use of the land surrounding the reservoir would be continued. No relocation of roads would be necessary. Construction materials for the enlarged structure are obtainable from nearby borrow areas.

The projected operation of the enlarged Gross Reservoir would be very similar to current operations except that the present maximum water-surface elevation (7,827 feet) would reach a higher elevation (7,400 feet) during the spring and summer. The operation would continue in its current pattern during the winter and fall.

With the enlargement of Gross Reservoir, future diversions from the DWB's west slope Williams Fork-Fraser Water Collection System would be greatly increased. The annual historical diversions from the Fraser River System of about 48,000 acre-feet would be increased to approximately 87,000 acre-feet. Present Williams Fork System diversions would be increased from a present average of approximately 5,000 acre-feet to 17,600 acre-feet annually. This increased Williams

Fork River collection would also increase the base flow in a 3.5 mile reach of Vasquez Creek by 18 cfs between Vasquez Tunnel and the Fraser River collection facility.

The total increased yield from these two collection systems, with Gross Reservoir enlargement, would average about 52,000 acre-feet annually. This would require all collection facilities to be operated continually during the water year.

The average annual flow of the 18.3 mile reach of South Boulder Creek between the east portal of the Moffat Tunnel and Gross Reservoir would increase from 72.5 cfs to 144.5 cfs (52,000 acre-feet).

With increased diversions by DWB's collection and storage facilities on the Fraser, Williams Fork, and Blue Rivers, more replacement and exchange releases from Williams Fork Reservoir could be made to accommodate downstream senior rights.

Present Environment

Soils and Terrestrial Resources. The soils in the South Platte River System area are generally well drained and located on moderately to highly sloping relief. The predominant parent materials are igneous, Pike's Peak granite, and metamorphic, gneiss and biotite schist. Soils are mostly light-textured, sand to sandy loam, and frequently gravelly. Rock talus, pieces of cobble-sized granite, often dominate the canyon bottom. Soils of the south-facing slopes tend to be thinner than those on north-facing slopes which have more vegetation and have undergone less erosion (BR 1973). A more detailed description of soils follows under a separate heading.

The primary vegetative types in the South Platte River System study area (5,500 to 7,800 feet) are (1) ponderosa pine--shrubland (chaparral) complexes, (2) Douglas fir--ponderosa pine mixed forests, and (3) cottonwood--willow riparian (streamside habitat).

-The Ponderosa Pine-Chaparral Complex. This vegetative community occupies sunny south-facing uplands and canyon slopes throughout the area. Generally, pine trees are quite widely-spaced and the understory vegetation is extremely abundant and diverse. Blue grama and June grasses provide principal ground cover, while scrub (Gambel's) oak and mountain mahogany are the dominant shrubs. Other plants commonly found in this vegetative community include (1) big and little bluestem, needle-and-thread, mountain muhly, wheatgrass, bluegrass, (2) shrubs--antelope-brush, big sage, saltbush, wax currant, gooseberry, rabbitbrush, snowberry, three-leafed sumac, yucca, (3) cactus--prickly pear and mountain ball, and (4) forbs--locoweed, geranium, cinquefoil, paintbrush, and yarrow.

As this shrub-dominated vegetative type is snowfree most of the

As this shrub-dominated vegetative type is snowfree most of the year, it serves as critical winter range for mule deer, elk, and bighorn sheep. Other mammals found in this ecosystem include desert cottontail, Abert's squirrel, black bear, porcupine, mountain lion, bushy-tailed woodrat, coyote, bobcat, and Colorado chipmunk. Representative birds include mountain chickadee, yellow-bellied sapsucker, red-shafted flicker, and Steller's jay. Rocky cliffs within the shrubland community are a preferred nesting habitat for the prairie falcon and golden eagle. Also the western rattlesnake, garter snake, tiger salamander, and Woodhouse's toad often occupy this habitat type.

-Douglas Fir-Ponderosa Pine Mixed Forests. Variations of this vegetative type are common in the South Platte Canyon. Since pine saplings are intolerant of shade, stands of Douglas fir predominate on the steep, moister, north-facing slopes. Where slopes are not quite so severe, the crown closure of Douglas fir is not complete and ponderosa pine are more abundant. Open stands of ponderosa pine dominate the drier, more exposed canyon uplands.

Other plants commonly found in the ponderosa pine-Douglas fir association include (1) grasses--fescue, brome, (2) shrubs--common juniper, Rocky Mountain maple, chokecherry, ninebark, gooseberry, kinnikinnik, wild rose, rock spirea, and (3) forbs--cinquefoil, penstemon, stonecrop, anemone, yarrow, and paintbrush.

The ponderosa pine-dominated forest characteristically has a much more abundant and diverse understory vegetation than either the Douglas fir-dominated stands or ponderosa pine-Douglas fir mixed forest, and thus supports a more diverse wildlife community. Several species of wildlife (for example, the locally abundant tassel-eared Abert's squirrel) are dependent on the ponderosa pine forest for food and cover. Also, the Merriam's turkey is apparently dependent on ponderosa pine trees for roosting habitat. Other mammals typically occupying the openings of ponderosa pine stands include the coyote, white-tailed jackrabbit, badger, mule deer, northern pocket gopher, meadow vole, and a variety of ground squirrels. The pygmy nuthatch and mountain bluebird prefer to nest in ponderosa pine forests.

Mammals typically found in ponderosa pine-Douglas fir mixed stands are the black bear, mule deer, porcupine, bushy-tailed woodrat, and Colorado chipmunk. Birds characteristic of this ecosystem include the mountain chickadee, broad-tailed hummingbird, Steller's jay, downy woodpecker, and yellow-bellied sapsucker.

-Cottonwood-Willow Riparian Vegetation. In this habitat type, stands of narrow-leaf cottonwood and thickets of peachleaf willow are interspersed liberally by Colorado blue spruce, aspen, and birch. A variety of shrubs (e.g., chokecherry, box elder, wild plum), grasses (needle-and-thread, wheatgrass), forbs (cow parsnip), sedges, and

rushes also contribute to the dense bands of vegetation that parallel the streambeds.

Area mammals most dependent on riparian habitat include the beaver, mink, water shrew, cottontail rabbit, raccoon, striped skunk, and mule deer. Birds commonly found along the canyon bottom include the dipper (water ouzel), broad-tailed hummingbird, loggerhead shrike, western flycatcher, warbling vireo, mallard, blue-winged teal, great horned owl, belted kingfisher, yellow warbler, mourning dove, brown thrasher, and Swainson's hawk.

The Woodhouse's toad and leopard frog are amphibians that commonly inhabit the stream bottoms. Also, an abundance of insects, mostly aquatic forms, are ususally present.

Generally speaking, the soils in the Roberts Tunnel System may be classified as cold, deep to moderately deep, and well drained. They range in location from gently sloping to nearly level (immediately around Dillon Reservoir and its tributaries) to steeply sloping and sheer rock outcrops and slides (in the uplands of the surrounding drainage basin). Parent materials are mostly granite gneiss (Bureau of Reclamation (BR) 1973). A more detailed description of soils follows under a separate heading.

The primary vegetative types within this elevation range, 8,500 to 11,500 feet, are (1) ponderosa pine-Douglas fir mixed forests, (2) lodgepole pine stands, (3) Aspen groves, (4) sprucefir forests, (5) upper montane-subalpine dry meadows, (6) upper-montane-subalpine wet meadows, and (7) high mountain forest riparian.

The ponderosa pine-Douglas fir mixed forest has been previously described herein for the South Platte River System.

-Lodgepole Pine Stands. In this area, this vegetative type generally occurs above 8,500 feet and results from the disruption of climax vegetative communities, especially by fire. Depending on elevation, they are succcessional either to Englemann spruce subalpine fir or ponderosa pine-Douglas fir forests. Following establishment, dense growths of young lodgepole pine drastically reduce the amount and diversity of understory development. Thus, these stands of "dog-hair" lodgepole generally provide poor wildlife habitat. However, over the years, the stands do begin to age and thin out, allowing seedlings of the appropriate climax vegetation to appear.

Understory vegetation of lodgepole pine forests is dominated either by kinnikinnik (bearberry) or huckleberry (blueberry), depending on elevation. Other plants which may occasionally find living space in lodgepole pine forests include (1) trees--limber pine, (2) forbs--golden banner, lupine, anemone, locoweed, (3) June grass, and (4) club moss.

Generally, only animals which rely on pine seeds as a primary food source prefer lodgepole forests, including the red squirrel (chickaree), Clark's nutcracker, gray jay, Steller's jay, and Colorado chipmunk.

-Aspen Groves. These ecosystems are also a disturbed area, subclimax vegetative type. Within this area, aspen groves have characteristically invaded the coarse soils of exposed ridges. Aspen can readily occur in extremes of elevation and soil moisture conditions. Young stands of aspen are quite dense but still permit sufficient light penetration for development of abundant and diverse understory vegetation. Thus, aspen groves usually support more diverse wildlife communities than do stands of lodgepole pine.

Typical understory vegetation includes (1) seedlings of Englemann spruce, subalpine fir, lodgepole pine, Rocky Mountain juniper, and Douglas fir, (2) a wide variety of forbs and shrubs (e.g., yarrow, pussytoes, mountain strawberry, blue columbine, sego lilies, dandelion, Oregon grape, elderberry, fringed sage, wild rose, buffalo berry, spreading juniper, chokecherry, and (3) several grasses and sedges.

Aspen are a critical food source for beaver and elk, especially during the winter months. Representative birds include the blue grouse, tree swallow, Williamson's sapsucker, red-shafted flicker, hairy woodpecker, Steller's jay, and gray jay.

-Englemann Spruce-Subalpine Fir Forests. These vegetative communities are the dominant climax vegetative type above 9,500 feet in the concept area. Usually this growth occurs in dense stands with overlapping canopies on steep, rocky slopes. Spruce-fir stands often contain a few widely scattered lodgepole and aspen. The understory vegetation forms a continuous ground cover and it is dominated by broom huckleberry (mountain blueberry). But, due to the normally heavy snowpack, greater than in any other Rocky Mountain life zone, fire does not pose a serious threat to this ecosystem. Often, snow does not completely recede from the spruce-fir zone until late summer. Other spruce-fir understory vegetation includes (1) forbs--arnica, lousewort, tall chiming bells,Jacobs ladder, blue columbine, American bistort, (2) several grasses and sedges, and (3) shrubs--redberried elder, prickly currant. This habitat type is used by both elk and deer as summer range and by bighorn sheep, on occasion, during all seasons. Other mammals exhibiting a definite preference for the spruce-fir forests include the blue grouse, mountain chickadee, Clark's nutcracker, gray jay, common raven, and goshawk. Also, white-tailed ptarmigan winter in the upper fringes of this ecosystem.

-Subalpine Dry Meadows. In the concept area, these ecosystems occur on level to gently-rolling terrain, between 9,000 and 11,000 feet, and are typically found in close association with

scattered lakes and streams. Usually these meadows appear quite shrubby including cinquefoil, willow and aspen saplings, and wild rose. the meadow edges are usually dominated by aspen groves which gradually blend into the surrounding spruce-fir forests.

Common grasses of the dry meadow include tufted hairgrass, alpine timothy, blue joint reedgrass, and bluegrass. Characteristic forbs include antennaria, yarrow, daisies, primrose, larkspur, blue columbine, arrowlead balsamroot, and paintbrush.

-Upper Montane-Subalpine Wet Meadow. This ecosystem is very distinctive from the dry meadow due to its extremely high soil moisture content. It also differs from the streamside riparian ecosystem, primarily because it covers much larger areas and is associated with non-moving or only moderately-moving water bodies. Commonly occurring vegetation includes (1) shrubs--snow willow, arctic willow, bog birch, (2) grasses--blue grama, bog bluegrass, reedgrass, brome (3) forbs--elephantella, white marsh-marigold, king's crown, gentian, buttercups, sedum, pussytoes, golden banner, stonecrop, and (4) sedges and rushes.

The subalpine wet meadow habitat type provides high quality food and cover for wildlife throughout the year. Mule deer often depend on the willow bogs for browse. Beaver regularly dam up the streams, helping maintain the water level and perpetuate the ecosystem. Other characteristic mammals include the meadow vole, northern pocket gopher, coyote, and water shrew.

Nesting birds include the mallard and blue-winged teal (near standing water), and the robin, warbling vireo, and song sparrow (dense willow thickets). The abundance of voles and other small mammals make this habitat type an important source of prey for such raptors as the red-tailed hawk.

-High Mountain Forest Riparian. Commonly occurring between 9,000 and 11,500 feet, this vegetative type is characterized by mixed stands of Englemann spruce, subalpine fir, and aspen directly bordering both sides of small tributary streams on moderate to steep slopes. The forest canopy completely encloses the streambed in many locations. Thickets of snow willow, arctic willow, bog birch, and river birch are typically scattered throughout the streambed. Marshy streambanks support a diversity of forbs, grasses, sedges, rushes, mosses, and lichens. Some of the more common water-loving plants are mertensia, elephantella, queen's crown, and marsh marigold.

Wildlife often concentrate along these small mountain stream courses, as they afford good sources of browse and water directly adjacent to dense cover. Beaver depend on streamside willow and aspen for food and dam-building material. Mink and water shrews are both highly dependent on stream ecosystems for food and cover. Mule deer

readily browse willow and aspen. Characteristic stream-dwelling birds include the dipper (water ouzel), western flycatcher, warbling vireo, and broad-tailed hummingbird.

In general, soils of the Williams Fork-Fraser River drainage of the Moffat System should be similar to those previously described for the Roberts Tunnel System.

The primary vegetative types found in the Williams Fork-Fraser River area (8,900-11,000 feet) are (1) lodgepole pine stands, (2) aspen groves, (3) spruce-fir forests, (4) subalpine dry meadows, (5) upper montane-subalpine wet meadows, and (6) high mountain forest riparian. The dominant plant and associated wildlife species characteristically found in each of these ecosystems have been previously described for the Roberts Tunnel System.

Surface deposits in the Gross Reservoir-South Boulder Creek area of the Moffat System are primarily colluvium, slope wash, talus, alluvium, and man-made fill. Colluvium is composed of angular rock fragments that have accumulated by gravity. Some of this colluvial material has been worked and redeposited by water and is referred to as slopewash; it ranges from silt-size particles to boulders several feet thick. Colluvium and slopewash generally occupy gentler slopes and benches in the bedrock and are less than 5 feet thick. Talus is colluvium that has been deposited in cone or fan-shaped forms. Alluvium is sand, gravel, cobbles, and boulders deposited along and in a stream channel. Drill holes indicate that the alluvium in the study area ranges from 12 to 26 feet in depth (DWB 1976). The primary bedrock unit in the Gross Reservoir area is a hard, medium-to-coarse-grained granite. A more detailed description of soils follows under a separate heading.

The primary vegetative types found in the Gross Reservoir-Boulder Creek area are (1) ponderosa pine shrubland (chaparral) complexes, (2) Douglas fir-ponderosa pine mixed forests, and (3) cottonwood-willow riparian (streamside) habitat. The dominant plant and associated wildlife species found in these three ecosystems have been previously described herein for the South Platte River System.

This information was excerpted from the Soil Conservation Service's Range Site Descriptions for the State of Colorado. These soil descriptions apply to general geographic areas (referred to as range sites), climatic conditions, and climax vegetative associations (e.g., wet meadow, subalpine forest) at specific elevations.

In order to avoid redundancy, this information is presented as a single entity in lieu of individual discussions for each of the three systems. However, the nature of soils within each of the three Concept A areas may be acquired from careful analysis of the summary

of range site descriptions shown on Table 8-7 and in the brief descriptions of climax zones which follows.

Generally speaking, the soils of the Subalpine Forest Climax are loams to light-clay loams, very dark brown or black due to high organic matter, neutral to slightly acidic, and eight or more inches thick. Water storage capacity is moderate to high and, coupled with natural fertility, encourages good production of vegetative biomass.

The soils of the Upper Montane Forest Climax (9,000-10,000 feet) are diverse; all are loams, but they vary in texture and depth.

The Lower Montane-Upper Montane Ecotone may contain all of the range site descriptions within the Upper Montane Climax. The general categories of soil moisture and precipitation are also applicable to this ecotone, with the possible exception of a slightly longer growing season and a lesser percentage of the precipitation occurring as snow.

Lower Montane Forest Climax is found between elevations of 6,000 to 7,500 feet. Many of the range sites described under the Upper Montane Climax and the Lower Montane Climax also occur at the upper level of this climax type (rocky loam, mountain meadow, stony loam, loamy park, mountain loam, and shallow loam). The predominant soils of the lower montane are referred to as foothill types. The foothill soils are generally not as coarse as those of higher elevations and tend to have clayey or sandy textures.

Within the study area, the Grassland-Foothill Climax occurs between 5,000 and 6,000 feet and contains elements of the foothill range sites plus the sandy meadow soil type discussed in the previous section, Lower Montane Forest. In general, the montane soil types abut or overlap the upper elevations at which the Grasslands-Foothills Vegetative Climax begins.

Aquatic Resources. The South Platte River between Deckers and Waterton is an extremely productive trout stream. A recent three-year sampling indicates that there are approximately 114 pounds per acre of trout in this stream reach (personal communication, Fish and Wildlife Service (FWS) 1977) consisting primarily of rainbow and brown trout (Table 8-8). Rainbow trout population is maintained with stocking program and natural reproduction, while the brown population is sustained through natural reproduction. This river reach is also highly productive of trout food organisms (International Engineering Corporation (IECO 1973)). Dominant aquatic invertebrates are mayfly naiads, with dipteran larvae and flatworms making important contributions to the invertebrate biomass.

The North Fork of the South Platte River is a moderately productive cold-water fishery, consisting primarily of rainbow, brown, and brook trout, although there are reportedly very few brook trout in

RANGE SITE CHARACTERISTICS

Range Site	Texture	Depth (inches)	Slope (percent)	Water Holding Capacity	Precip.	Vegetative cover	Other
Subalpine Forest Climax							
Subalpine Loam	loam to clay loam	8+	--	moderate to high	--	Mountain parks-open grassland	very dark color slightly acidic
Wet Meadow	sandy loam to sand and peates and mucks	8+	mostly 0-3	moderate to high	--	meadow	very dark color acidic, poorly drained
Upper Montane Forest Climax							
Rocky Loam	cobbly loam	8	3-25	low	15-20"	forest-25% cover	
Mountain Loam	gravelly loam to loam	8-12	5-40	moderate	--	forest	
Loamy Park	fine sandy loam to loam	12+	3-40	moderate to high	15-20"	open grassland with some trees, 40% cover	dark color 50-100 day frost-free period
Shallow Loam	loam to fine sandy loam	12	2-40	moderate	15-20"	mixed forest and grass	dark color 90-110 day frost-free period
Mountain Meadow	sandy loam to loam	24+	3-40	moderate to high	15-20"	open grassland	dark color 50-100 day frost-free period
Lower Montane Forest Climax							
Loamy Foothill	loam to clay loam	12-24	2-20	moderate	12-16"	--	130-150 day frost-free period
Shaly Foothill	clay loam to sandy clay loam	8-36	2-20	high	15-19"	--	120-150 day frost-free period
Gravelly Foothill	gravelly loam to gravelly sandy clay loam	12-24	5-20	moderate	13-16"	30% optimum	
Cobbly Foothill	cobbly clay loam	12-36	5-20	high	15-18"	--	--
Rocky Foothill	stony loam	24+	5-29	moderate to high	11-16"	--	120 day frost-free period
Shallow Foothill	sandy loam to loam	20	0-35	low to moderate	11-16"	25% optimum	120-150 day frost-free period

TABLE 8-7 (cont.)

RANGE SITE CHARACTERISTICS

Range Site	Texture	Depth (inches)	Slope (percent)	Water Holding Capacity	Precip.	Vegetative cover	Other
Sandy Foothill	loamy sand to sandy clay loam	24+	2-10	moderate	11-16"	35% optimum	120-150 day frost-free period
Sandy Meadow	sandy loam to loamy sand	24+	0-3	low to moderate	13-17"	--	salty, high water table
Grassland Foothills Climax							
Loamy Plains	loam	24+	0-10	high	11-17"	35% optimum	160-170 day frost-free period
Sandy Bottomland	sandy loam to sand	36+	0-10	low to moderate	13-17"	40% optimum	--
Wet Meadow	sandy loam to loamy sand	12-36	0-6	moderate	13-19"	60% +	salty, high water table
Clayey Plains	clay loam to clay	24+	2-30	high	13-17"	40% optimum	slow water intake rate
Salt Flat	clay loam to clay	24+	0-6	high	11-19"	25%	saline, sodic
Salt Meadow	sandy loam to clay loam	12+	0-4	moderate	10-19"	50% +	saline, sodic, high water table
Gravel Breaks	gravelly sandy loam to gravelly sand	6-24	4-20	low	13-17"	30% optimum	--
Overflow	sandy loam to clay loam	36+	0-6	moderate to high	13-19"	50% +	alluvial soils

TABLE 8-8

FISH SPECIES (PERCENT COMPOSITION) - SOUTH PLATTE DRAINAGE

Stream or Reservoir	Rainbow Trout	Brown Trout	Brook Trout	Cutthroat Trout	Suckers	Kokanee Salmon	Yellow Perch	Other
Cheesman Reservoir	5%	3%	-	-	30%	1%	60%	Trace 1/
South Platte River:								
Cheesman to Deckers	35%	60%	-	-	5%	-	-	-
Deckers to Waterton	50%	45%	-	-	5%	-	-	-
Waterton to Bear Creek	95%	5%	-	-	Trace	-	-	-
Bear Creek Downstream	-	-	-	-	40%	-	11%	49% 2/
North Fork 3/	91%	8%	1%	-	-	-	-	-
Gross Reservoir	12%	1%	-	-	87%	-	-	-

Source: CDW, unpublished stream surveys.

1/ Includes walleye, whitefish, northern pike, carp, and mackinaw.

2/ Rough fish primarily, includes carp (25%), chub (19%), bullhead (3%), sunfish (2%), and trace of channel catfish and bass. Also reportedly lake whitefish, mackinaw, and northern pike (IECO, 1973).

3/ IECO (1973) reports presence of longnose suckers, and probably white suckers, long-nosed dace, creek chub, and various other minnows.

TABLE 8-8 (cont.)

FISH SPECIES (PERCENT COMPOSITION) - COLLECTION SYSTEM

Stream or Reservoir	Rainbow Trout	Brown Trout	Brook Trout	Cutthroat Trout	Suckers	Kokanee Salmon
Williams Fork Reservoir	15%	1%	1%	-	3%	80%
Williams Fork River - Site 1	30%	70%	-	-	-	-
Williams Fork River - Site 2	70%	20%	10%	-	-	-
South Fork (Williams Fork)	10%	-	90%	-	-	-
North Fork (Williams Fork)	-	-	100%	-	-	-
Keyser Creek	20%	-	80%	-	-	-
Other Tributaries - Williams Fork	-	-	100%	-	-	-
Dillon Reservoir	60%	20%	5%	-	-	15%
Straight Creek	-	-	60%	40%	-	-
Fraser Reservoir #1	75%	1%	20%	-	4%	-
Fraser River #2	40%	10%	50%	-	-	-

Source: CDW, unpublished stream surveys.

the lower reach (IECO 1973). The stream habitat has been disrupted by channeling to increase the flow capacity and is subject to fluctuating releases from Roberts Tunnel, neither of which is conducive to high productivity. The benthic fauna is considerably sparser than that of the main stem. The benthos is dominated by aquatic insects, i.e., caddisfly and mayfly naiads (IECO 1973).

There are few data on the fish fauna of Cheesman Reservoir, since it is not managed as a sport fishery. Indications are that the reservoir is unproductive and overpopulated with stunted yellow perch (IECO 1973).

Dillon Reservoir supports a trout and salmon fishery dominated by rainbow trout. Although natural reproduction is good in the tributary streams, the reservoir is also stocked on a regular basis. Recent improvements to Tenmile Creek to provide fish habitat should increase natural reproduction. The fishery is rated as being of state and local importance. However, there has been concern over the excessive growth of rooted aquatics in the Blue River arm of the reservoir.

In the Moffat System, Williams Fork River and its tributaries support cold-water fisheries of varying local significance. The main stem and the South Fork are regularly stocked, while the headwater tributaries are occasionally-to-never stocked. The main stem supports the most varied fishery. The tributaries support a less varied fishery, in all cases dominated by brook trout in their lower reaches; in the headwaters, cutthroat trout usually dominate. In the majority of streams dominated by brook trout, there is a tendency to overpopulate. Sculpin are also present throughout the basin but do not contribute to the fishery.

The primary fish food organisms in these streams are aquatic insect larvae. The dominant insects are mayflies, followed by stoneflies (CH_2M Hill 1976). On the whole, the tributaries range from low-to-moderate productivity, while the main stem is rather highly productive of aquatic insects.

The Fraser River also supports a cold-water fishery. Rainbow trout dominate in the lower reaches, with brook trout rising to dominate in the upper reaches. The benthos is dominated by mayfly and caddisfly naiads in both the river and its tributaries; dipteran larvae inhabit the slower water areas (Colorado Division of Wildlife 1966, in EPA 1976).

Gross Reservoir is another storage reservoir for the DWB. It is open to shore fishing but provides a rather poor sport fishery, since it is dominated by sucker.

Water quality of the South Platte System has been previously discussed in the description of the environment for the Strontia

Springs Diversion Dam and Foothills Water Treatment Plant. The previous discussion is equally applicable to this section.

Water diverted to the South Platte system is stored in Dillon Reservoir. This water is also regularly analyzed by the DWB. These analyses show that the water in Dillon Reservoir is also quite suitable for a municipal water supply and well within standards (DWB 1973, 1974, 1975, and 1976). However, the salinity of water in Dillon is somewhat higher than that of the water from the Williams Fork System or Gross Reservoir; salinity in Dillon Reservoir ranges from 26 to 200 mg/l and averages around 100 mg/l.

Samples collected in the Williams Fork Collection System during the diversion season exhibited concentrations of dissolved solids ranging from 39 to 58 mg/l (CH_2M Hill 1976), with an average of 50 mg/l. Analysis of samples from Gross Reservoir (DWB 1974, 1975, and 1976) show that the water is well within water quality standards for drinking water.

Important Wildlife Species. Except where otherwise referenced, this descriptive information was excerpted from the article by Jones and Jones (1977) in the appendix of this environmental statement. In the early 1800s, 1.5 to 2.0 million bighorn sheep (*Ovis Canadensis*) resided on the North American Continent; however, due to excessive hunting, disease, competition from livestock, and habitat destruction, only 7,000 to 8,000 sheep remained in Colorado by the early 20th century. Today, Colorado's mountains support about 2,000 bighorns, which are divided into several scattered, intensively managed and researched herds, concentrated primarily to the east of the Continental Divide. The South Platte Canyon of the South Platte River System supports one of these bighorn herds, presently numbering about 60 to 65 animals (personal communication, Colorado Division of Wildlife (DOW 1977)).

During the years 1954 to 1966, hunting of the bighorn sheep was allowed in the South Platte Canyon. In total, 42 animals were taken by 92 licensed hunters. This high hunter success ratio (47 percent) is partially due to the relative accessibility of these sheep and their adaptation to the presence of humans.

With the exception of a few bow licenses, hunting was stopped in 1967. The lack of intensive hunting pressure has increased the herd's tolerance to the presence of man. Due to the large volume of hikers, bicyclists, and fishermen which infiltrate the canyon every weekend, the sheep show little regard for human presence. During a 1977 field trip to the canyon, a group of 13 sheep (2 rams, 8 ewes, 3 yearlings) permitted an ivestigator a direct-line-of-vision approach to within 20 yards.

Golden eagles (Aquila crysaetos) are protected from hunting and harassment by federal law. Golden eagles have historically nested and hunted up and down the South Platte Canyon as well as the North Fork of the South Platte. They also have been observed in the Williams Fork-Fraser River drainage. Golden eagles have been reported as nesting in every subalpine habitat in Colorado (DOW 1976).

-Other Game Species. The most common big game species in the Concept A study area is the mule deer (Odocoileus hemionus) followed closely by elk (Cervus canadensis). The Williams Fork collection system is located in Grant County which is among the top 10 in elk harvests (DOW 1974). The mule deer harvest in this county approached 2,000 animals (DOW 1974), and this area is considered good to excellent for both winter and summer range for these species. Black bears (Ursus americanus) are also common at the lower and intermediate elevations. Mountain lions (Felis concolor) are also found in the potential Two Forks Reservoir area. The population is believed to be low and decreasing due to human disturbance. One animal was taken in the vicinity of Two Forks during the 1974 hunting season (DOW 1974).

Cottontail rabbits (Sylvilagus floridanus) are the most common game species at the lower elevations, while snowshoe hares (Lepus americanus) dominate altitudes above 8,000 feet.

The most common game bird species within the Concept A study area is the mourning dove (Zenaida macroura). DOW records for 1974 indicate that more than 55,000 of these birds were harvested. The waterfowl harvest of all species for the same period exceeded 15,000, the majority of which were taken in Boulder County. Other game species of note were blue grouse (Dendragapus obscurus), sage grouse (Centrocercus urophasianus), sharptailed grouse (Pedioecetes phasianellus), bobwhite quail (Colinus virginianus), scaled quail (Callipepla squamate), band-tailed pigeon (Columba fasciata), ringnecked pheasant (Phasianus colchicus) and a few wild turkeys (Meleagris gallapova). Generally speaking, the grouse species inhabit the higher and middle elevations, while the remaining game species occupy the foothills and grassland plains areas. The above lists are not complete but are representative of the game animals occurring in the area.

Endangered Species. The State of Colorado has classified the river otter (Lutra Canadensis) as an endangered species. During the summer of 1976, the Colorado Division of Wildlife introduced three otters, obtained as a gift from Newfoundland, into Cheesman Reservoir on the South Platte River drainage. Although the present status and location of the introduced otters is unknown, the DOW has classified portions of the South Platte River drainage as essential habitat for this species (DOW draft report 1976).

-Southern Bald Eagle. During the last two years, there have been several sightings of a pair of endangered southern bald eagles near Deckers (personal communication, DOW 1977).

-Peregrine Falcon. The State of Colorado has classified portions of the North Fork of the South Platte River and the main South Platte River as essential habitat for the endangered peregrine falcon (*Falco peregrinus*). A nesting pair of peregrines has been hunting up and down this stream for several years (personal communication, DOW 1977). The peregrine falcon has also been reported nesting in the south Boulder Creek area (DOW 1976). The State of Colorado has identified the Gross Reservoir vicinity as essential habitat for this raptor.

-Others. According to the 1976 DOW draft report on endangered species, the Canadian lynx (*Lynx canadensis*) has essential habitat within the South Platte area. Recent communication with DOW personnel indicated that the status of these two species in the South Platte Canyon is unknown.

The Canadian lynx and wolverine also historically occupied habitat in the Williams Fork-Fraser River watershed (DOW 1976). Both species prefer to reside in undisturbed tracts of subalpine forests which are common in this area (Burt and Grossenheider 1976).

According to the DOW draft report, historic ranges for three endangered species, the grizzly bear, (*Ursus horribilis*), gray wolf (*Canis lupus*), and black-footed ferret (*Mustela nigripes*) overlap parts of the Concept A area. The State of Colorado has, to date, not published a listing of endangered reptiles and amphibians.

The Boulder Creek watershed probably provided habitat, historically, for the federally endangered greenback cutthroat trout (*Salmo clarkii stomias*). Presently, a tributary to North Boulder Creek, downstream from Gross Reservoir, contains a population of greenback cutthroat trout (personal communication, DOW 1977).

No other endangered fish species are known to exist anywhere in the Concept A study area (personal communication, DOW 1977).

The Federal Register (50 CFR, Part 17) lists 30 plants as proposed endangered species for the State of Colorado. Since the Concept A study area encompasses such a broad vegetative spectrum, it is probable that one or more of these plant species could be present. However, the Federal Government has not designated any habitat as critical for endangered plants, and the State of Colorado has not published an official endangered plant list.

Socio-Economic Conditions, Recreation, and Cultural Resources. The South Platte River System area is rural in character and depends almost totally on the import of goods and services from surrounding

urban centers. Only small areas of land are flat enough for cultivation. Some livestock grazing does occur, but it is not practiced on a large commercial basis. One valid mining claim exists near Deckers. There are no significant export industries. The entire local economy is based on small restaurants, service stations, and groceries, serving residents and the vacationer-recreationist.

The existing visual environment for the South Platte River System would be the same as described in Chapter 2.

Most of the population in the area (about 141 full-time residents) is concentrated in small unincorporated communities or in scattered residences on both the North and South Forks of the South Platte River. Of the full-time residents, many are retired and over 65 years of age. These older persons are long-time residents of the South Platte Valley, many having lived there for 20 to 50 years.

Since most of the area lies within national forest boundaries and little privately owned land is available, population has remained fairly constant for many years. Some people live in the area because of relatively low housing costs, but most seem to prefer the area because of its rural environment. The permanent residents have a strong sense of community identification within their own communities or settlements.

Small communities or settlements in the area include Buffalo Creek, Pine, South Platte, Dome Rock, Foxton, Twin Cedars, Nighthawk, Oxyoke, Trumbull, Deckers, Ferndale, and Longview. None of these communities have formal political structures since they are unincorporated.

Residents of the area feel that the long threat of implementing water storage development, along with attendant uncertainties, has retarded development and population growth. They also feel that the area has been ignored by public agencies reluctant to spend money on facilities or improvements that might soon be inundated.

Between the towns of Deckers and South Platte, recreational use is heaviest. User congestion, road dust erosion, vandalism, littering, and sanitation problems occur as well as competition between recreationists--especially between fishermen and tubers--for the use of the river adjacent land areas. Nevertheless, this is an important recreation area to residents of the Denver and Colorado Springs metropolitan areas as well as the canyon residents (BOR 1974a).

Law enforcement is provided by both Douglas and Jefferson Counties Sheriff's departments. Buffalo Creek and Pine serve residents in the northern part of the area.

Flooding along the South Platte River has endangered the security of life, health, and safety of residents in the valley.

Recreation opportunities are abundant in the area. Visitors to the South Platte-North Fork area come primarily from the Denver and Colorado Springs metropolitan areas, both of which are within a travel distance of one and a half hours.

Major reservoirs of the upper South Platte River System include Antero (1,000 surface acres), Elevenmile (1,400 surface acres), Cheesman (875 surface acres), and Chatfield Lake (25 surface acres).

Antero Reservoir had 55,000 visitor days in 1971; it is highly productive for rainbow, brown, and brook trout. Elevenmile Reservoir had 182,000 visitor days in 1971; it has natural reproduction of rainbow and brown trout besides regular stocking.

Cheesman Reservoir is closed for public use; however, adjacent land areas and the dam and South Platte River immediately downstream receive several thousand visitors annually. Major activities include auto driving, hiking, motorcycling, cold-water fishing, and big-game hunting. The annual recreation use is substantially below the recreation potential of the reservoir. Cheesman Dam, completed in 1905, is on the Historic American Civil Engineering Record.

The South Platte River from Antero Dam to Waterton is a unique and valuable recreation resource. It provides good fishing for rainbow and brown trout because it is heavily stocked. Only 3 to 4 miles of water is open to the public between Cheesman Reservoir and the Wigwam Club.

The river reach from Deckers to the confluence with the North Fork provides a diversity of recreation opportunities, as shown in Table 8-9. There were 221,000 visitor days in 1971, with auto driving accounting for nearly 45 percent of the activity. Picnicking at 7.6 percent and fishing at 7.4 percent were next.

Fifty percent of the recreational use along and above South Platte River reach occurs on Saturday and Sunday, with the remainder spread fairly evenly over the rest of the week. Approximately 75 percent of the use occurs during the peak season between Memorial Day and Labor Day. Recreation demand far exceeds the facilities provided, and use would probably be much greater if additional facilities were provided. The absence of camping fees and restrictions is an added attraction to the young and low-income groups. One of the major recreational activities that has recently been developed in the area is motorcycling. In spite of efforts of off-road vehicle organizations to police their own activities, the physical environment in the area is being damaged by both motorcycles and four-wheel drive vehicles. Terrain damage and the irritating

TABLE 8-9

TYPES OF RECREATIONAL ACTIVITIES -- 1971
TWO FORKS MANAGEMENT COMPOSITE

Activity	Visitor Day Use (Thousands)	Percent Of Total
Auto Driving	99.3	44.9
Scooter-Motorcycle Driving	4.6	2.1
Ice Snow Craft Driving	.7	.3
Foot Hiking Walking	1.2	.5
Horse (Horseback Riding)	.3	.1
Canoe (Canoeing)	5.7	2.6
Other Watercraft (Rowing, Drifting, Rafting)	7.1	3.2
Swimming Bathing	5.5	2.5
Fishing (Cold Water)	16.3	7.4
Camping (General)	12.9	5.8
Camping (Auto)	14.4	6.5
Camping (Trailer)	12.4	5.6
Camping (Tent)	12.7	5.7
Organization Camping (General)	1.2	.5
Picnicking	16.8	7.6
Recreation Residence	5.4	2.4
Snow Play	.2	.1
Hunting (Big Game)	.3	.1
Hunting (Small Game)	.2	.1
Hunting (Waterfowl)	.5	.2
Nature Study	.1	.0
Gathering Forest Products	1.7	.8
Acquiring General Knowledge and Understanding	1.6	.7
COMPOSITE TOTAL	221.1	

Source: Computer Data File, Pike National Forest, Colorado, USFS 1971.

noise to most other recreationists and residents result in constant complaints. Use of motorized vehicles is prohibited in Waterton Canyon from Kassler to South Platte.

A National register of Historic Places site within the immediate Two Forks impact area is the North Fork Historic District (1974). This historic district extends from the confluence with the South Platte River up the North Fork to Pine.

A preserved portion of the Denver South Park and Pacific narrow gage railroad bed is also located along the North Fork from below South Platte to Bailey. The home of Elias M. Ammons, who was governor of Colorado from 1913 to 1915, is of interest. There are other National Register sites in the Buffalo Creek area, including LaHacienda, Green's Merchantile Store, Green Mountain Ranch, and the Blue Jay Inn. The sites are all under Section 106 protection of the 1966 Act.

Little is known with regard to prehistoric man's activities in the areas of investigation. Information gathered on the upper reaches of the canyon on both the North Fork of the South Platte and the South Platte proper indicates an occupation span from early Archaic (6000 B.C.) to the present time. The prehistoric materials indicate two major types of sites: occupation sites (mostly open camps), and special function sites. The occupation sites are most numerous where there is a relatively large amount of usable land area that is situated near water and at the junction of two or more microclimes. The sites seem to exhibit a uniformity in subsistence patterns through time. Although specific artifacts do change, their ultimate function does not.

Recent investigations (Windmiller 1974, Windmiller 1975a, Windmiller 1975b, and Emrick 1976) found some 70 prehistoric sites within the Two Forks area. Of these 48 have an unknown time period; 13 are of the Woodland time period; and 9 are of the Archaic time period.

DWB's Roberts Tunnel System centers around Dillon Dam and Reservoir and the west slope conservation and regulation of Blue River water flows provided by this facility. Almost all of the contributing area is within Summit County and the Arapahoe National Forest in central Colorado.

With completion of Dillon Dam in 1964, the new relocated town of Dillon quickly grew and changed the economic profile of the county from one of agriculture and mining to one based almost entirely on tourism.

Today, Summit County, including Dillon and the nearby communities of Frisco, Keystone, Silverthorne, and Breckenridge, provide a

mountain-rural setting with a combined population estimated at 6,500 (1977). This represents almost a three-fold increase in population growth since 1970. The general character of the population is one of youth and mobility. Many of the residents in the Dillon-Keystone and Breckenridge area live in mountain condominiums and cabins, many of which are second homes.

Summer tourism in Summit County is mainly centered around Dillon Reservoir and the major ski communities of Keystone, Breckenridge, and Copper Mountain. Dillon Reservoir has a surface area of 3,200 acres and provides popular public fishing and boating. Forest camping and picnic grounds and hiking trails are located around the reservoir. Dillon received 68,090 fisherman days (a twelve-hour day when fishing is the only activity participated in by any number of fishermen) on water, and 2,000 fisherman days on ice, in 1973. No specific activity statistics are available for the other water activities and related land recreation. However, an estimated 358,000 visitor-days of use occurred in the area during 1973 (Bureau of Land Management (BLM) 1976).

The Blue River and its many high mountain tributary streams and alpine lakes are noted for quality trout fishing. Other summer outdoor activities include unique hiking and camping opportunities in major national wilderness and primitive areas located in the Gore Mountain range. The Gore Range-Eagles Nest area became a designated wilderness in the wilderness system on July 12, 1976.

Green Mountain Reservoir (2,125 surface acres) located on the Blue River about 20 miles downstream from Dillon is considered a major recreation resource. The state park at the reservoir received 96,199 visitor days and served 4,182 boats in 1975.

Winter sports are centered around five major ski resorts--Loveland Basin, Arapahoe Basin, Keystone, Copper Mountain, and Breckenridge. Because of their close proximity to Denver, these resorts attract hundreds of thousands of people each year from across the nation.

At present, the only site that appears to qualify for the National Register is the Oro Grande Canal No. 1 and No. 2 right-of-way. Present information does not provide the age or condition of this structure. Other historic sites would be related to mining, settlement, ranching, and lumbering activities. there are no known prehistoric resources within the Roberts Tunnel System study area. Expected prehistoric resources would be similar to the Upper South Platte System due to the similarity of the terrain and vegetation.

The Moffat System lies in a scenic environment typical of the Front Range of the Rocky Mountains. The topography consists of

granitic foothills with a mixed forest cover of ponderosa, pine, and Douglas fir. Housing developments and road systems are common in the area. The scenery is typical of the Colorado mountains (Class B). Due to the number of mountain homes in the area, the visual sensitivity is high.

Gross Dam and Reservoir is located in Boulder County approximately 5 miles southwest of Boulder and 35 miles northwest of Denver.

About 10 percent of the 10 miles of reservoir shoreline is open for public fishing. Fishing is generally poor because of a high non-game fish population.

Nearby forest lands provide limited picnic opportunities. For safety and security reasons, no other recreation use has been permitted on the reservoir or surrounding land areas. Access to Gross Reservoir can be gained from Coal Creek Canyon Road (State Highway 72) via a dirt county road.

DWB caretakers and their families are the only residents in the immediate area. No agricultural, business, or industrial uses exist in the area.

The social and economic climate of the area around the town of Fraser in Grand County is primarily based on agriculture and tourism. Located between the ski slopes of Berthoud Pass and Winter Park and the water-based recreational facilities of the Colorado-Big Thompson Project near Granby and the Rocky Mountain National Park, the area is visited by skiers, boaters, fishermen, hikers, and others seeking the advantages of these recreational areas. Broad meadows are here, in which cattle graze, and crops adaptable to the climate are raised. The Fraser Experimental Forest is located directly to the west of the town of Fraser; it contributed to knowledge and research in the forestry industry.

Camping areas are situated south and west of Fraser, and lodging for tourists and recreationists is available in and near the town.

Permanent residents still intermingle with the transients, stabilizing the community, but gradually deferring to the younger generations. An indication of the economic and social climate of the area is the population increase in Grand County, from 4,100 in the 1970 census to an estimated 7,000 at present.

The Williams Fork and Fraser Rivers and their respective tributaries provide fair to good cold-water fishing opportunities. Williams Fork has many good holes and riffles and is considered one of the better fly-producing streams for rainbow and brook trout (Kelly 1975). Recreation activities in the Williams Fork drainage

primarily include fishing, camping (four campgrounds with 6,100 visitor days), hiking, hunting, horseback riding, and snowmobiling (CH_2M Hill 1976). The big-game hunting is primarily for mule deer (842 hunters with 23 percent success in 1973), elk (1,205 hunters with 18 percent success, 1973), and bear.

There are several historic resources in the Gross Reservoir area including the Denver and Salt Lake railroad bed and the South Boulder Creek flume. Historic resources in the Williams Fork-Fraser River collection areas are limited to small, isolated multiple structures associated with railroading, mining, logging, and ranching. There is one historic site on the National Register within the area: Rollins Pass.

Although there are no known archaeological sites in the Gross Reservoir area, it is expected that such resources would be similar to those in the Upper South Platte System. Very little prehistoric data has been derived from surveys (CH_2M Hill 1976) associated with the Williams Fork collection area. The two chipping stations and a number of isolated finds remain without temporal placement. It is likely that further survey and construction operations will encounter additional materials.

Analysis

Environmental Impacts

General. Construction of Concept A features would result in temporary, localized deterioration of air, noise, and water quality. Noise levels would be increased during construction periods, disturbing wildlife and nearby residents. Soil erosion would increase turbidity in surface water flowing from the construction areas. Increases in dust, hydrocarbons, nitrogen oxide, and carbon monoxide would result from the operation of construction machinery.

Topsoil and underlying soil and geologic formations would be disrupted during construction. Following construction, trenches and borrow areas would be backfilled and shaped to blend with the natural surroundings.

During construction, strict controls for the protection of wildlife and their habitat could be implemented. However, some terrestrial wildlife would be displaced and lost during construction due to elimination of vegetation within the construction rights-of-way.

Future implementation studies for any of the potential concept features that would be viewed as a significant federal action would require compliance with NEPA regulations. An environmental assessment of the impacts of the proposed action would be made. This would be

the basis for determining whether an environmental statement or a negative determination should be processed. If an environmental statement is required, it would be prepared in compliance with Section 102(2)(C) of Public Law 91-190, the National Environmental Policy Act (NEPA) of 1969.

Terrestrial Resources. The proposed Two Forks Reservoir in the South Platte River System would have a total water surface of 4,485 acres at the maximum water surface elevation of 6,457 feet. The reservoir would inundate and eliminate ponderosa pine-chaparral and Douglas fir-ponderosa pine vegetative types on the South Platte Canyon slopes from just above the streambed to the high water elevation (BR 1973). In addition, the cottonwood willow vegetative complex along 19 miles of the South Platte River, 7 miles of the North Fork of the South Platte River, and 9 miles of miscellaneous streams and gulches would be eliminated. The terrestrial plant and wildlife species most commonly found in these three vegetative associations have been previously described.

All trees within the reservoir area, up to elevation 6,400, would be mechanically removed and processed prior to inundation. The alternate flooding and drying of reservoir shoreline, resulting from operation fluctuations of the water surface, would restrict the growth of terrestrial vegetation. This could result in a zone of denuded vegetation, of varying width, encircling the reservoir during most of the year.

Wildlife populations would be displaced by the inundation of the Two Forks Reservoir area. The degree of impact would vary depending on the species involved. Birds, mammals, amphibians, reptiles, and insects dependent on streamside riparian habitat (e.g., beaver, dipper) would be most impacted. Displaced animals would be forced to relocate in adjacent similar habitat. Relocation success for each species will vary according to the availability of adjacent partially occupied habitat for that species (i.e., habitat which has not reached carrying capacity). Displaced animals which cannot find habitat within a reasonable migration distance of the project area could perish. Due to the extent of the inundation area, construction of Two Forks Reservoir would result in some loss of wildlife.

Average annual streamflows along a 6.5-mile reach of the South Platte River from the proposed Strontia Springs Dam to Chatfield lake would be reduced by approximately 90 percent, from the Two Forks Reservoir storage and diversions to the proposed Foothills Treatment Plant. This could result in prolonged periods of streamflows as low as 10 cfs through this reach of the South Platte Canyon. Tennant (1975) reports that, for a variety of streams studied, 10 percent flows would severely diminish the abundance and diversity of riparian vegetation. Such reduction in the quality of riparian habitat would also result in the displacement of terrestrial wildlife species.

Flows in a 37-mile reach of the North Fork of the South Platte would be increased by additional diversions from the west slope collection system. Releases from Roberts Tunnel could be coordinated to approximate the natural flow regime. While flows in the North Fork would be greater than those presently occurring, no additional stabilization would be required. By occupying more of the existing stream channel, these increased streamflows could result in the improvement of the quality of riparian habitat and associated terrestrial wildlife populations.

Construction of the Straight Creek diversion structure to feed the Roberts Tunnel System would eliminate approximately 2 acres of forest riparian habitat, as previously described. This could result in the displacement of some terrestrial wildlife. In addition, construction of the underground conveyance conduit from Straight Creek to Dillon Reservoir would disturb 12 acres of primarily spruce-fir forest interspersed with some subalpine dry and wet meadow habitat. This could also result in the temporary displacement of some terrestrial wildlife. Following construction of the conduit, the disturbed landscape could be recontoured and revegetated to as near natural conditions as possible.

As a result of the proposed diversion, streamflows would be depleted on approximately 90 percent (i.e., 16 cfs to 2 cfs) along a 3.5-mile reach of Straight Creek. Tennant (1975) has described a 90 percent reduction in annual streamflow as being destructive to riparian vegetation; thus, the diversity and abundance of the vegetative community along Straight Creek from the diversion structure to the Blue River would be diminished. This could result in some change in the nature of the associated riparian wildlife community. However, due to the extensive development (e.g., interstate highway, condominiums) which has already taken place along much of this stream segment, the degree of impact to remaining terrestrial ecosystems resulting from the potential action should be minimal.

Streamflows in a 22-mile stretch of the Blue River between Straight Creek and Green Mountain Reservoir would be reduced by 56 cfs during spring diversion periods. Given the present average spring flows of between 500 and 1,000 cfs for this river reach, the proposed flow reduction should have no impact on riparian vegetation and associated wildlife populations.

The increased streamflow diversions in the Williams Fork-Fraser River collection area of the Moffat System would reduce average annual flows by 90 percent on 37.3 miles of 13 tributary streams to the Fraser River. Elimination of much of the riparian vegetation, primarily subalpine wet meadow and high mountain forest riparian types, could be expected from such reductions in streamflow. Tennant (1975) reports that over the long-term 10 percent flows would severely diminish the quality of riparian vegetation.

Severe reduction in the abundance and diversity of riparian vegetation would result in the displacement of wildlife. Birds, mammals, reptiles, amphibians, and insects which are dependent on this riparian habitat for food and cover would be forced to relocate in adjacent partially occupied riparian habitat. Animals which are unable to find replacement habitat could perish. Due to the number (thirteen) and relative proximity of streams affected by the proposed depletion increases, some displaced wildlife would have difficulty relocating.

Proposed depletions would reduce the average annual flows of 2.5 miles of streams in the Williams Fork Basin an additional 30 percent. Increased depletions on these tributary streams could impact the riparian vegetative community and associated wildlife populations. The average annual flow of an 18.3-mile reach of South Boulder Creek between the east portal of the Moffat Tunnel and Gross Reservoir would double (72.5 cfs to 144.5 cfs). This increased streamflow could impact the abundance and diversity of the existing riparian vegetation. Similarly, the projected increase (18 cfs) in base flow on a 3.5-mile reach of Vasquez Creek, between Vasquez Tunnel and the Fraser River collection facility, could impact the associated riparian habitat. The nature of these impacts would depend on such factors as the morphology of the streambed, composition of the riparian vegetative community, and streambank water storage capacity.

The present surface area of Gross Reservoir at maximum storage capacity (43,065 acre-feet) is 432.1 acres, with a shoreline of 9.9 miles. The surface area of the enlarged reservoir (113,000 acre-feet) would be 803.5 acres with 12.1 miles of shoreline. The proposed enlargement would also inundate 3,000 feet of South Boulder Creek upstream from the existing reservoir. At maximum storage capacity, the Gross Reservoir enlargement would inundate 371.4 surface acres of vegetation, primarily ponderosa pine-Douglas fir mixed forests on north-facing slopes, and the ponderosa pine-chaparral association on south-facing slopes (DWB 1976). The plant and wildlife species most commonly found in these two vegetative types have been previously described. Inundation would eliminate the terrestrial vegetation from this acreage and also result in the displacement of terrestrial wildlife. As previously discussed, if adjacent, partially occupied habitat is available the displaced wildlife should be able to successfully relocate. However, if the adjacent habitat is already occupied to carrying-capacity for individual wildlife species, some of the displaced animals could perish. The abundance of similar habitat in the vicinity of Gross Reservoir should minimize the number of animals that would be unable to successfully relocate.

The habitat lost as a result of the inundation of South Boulder Creek would be primarily the cottonwood-willow riparian complex, (DWB 1976). Terrestrial vegetation would be eliminated in the area of

inundation, and associated wildlife would be displaced with the possible loss of some animals.

Aquatic Resources. Construction and operation of Two Forks Reservoir in the South Platte River System would inundate up to 19 miles of highly productive stream fishery on the main stem of the South Platte River, and 7 miles of a moderately productive fishery on the North Fork. This would be replaced by a reservoir fishery of variable surface acreage, usually between 2,050 and 3,200 acres. Productivity in the reservoir would be low and would probably be similar to that of Cheesman Reservoir. Cheesman Reservoir would be opened to fishing and provide an additional fishery of unknown quality and low productivity.

Additional east slope storage would allow for releases from Roberts Tunnel to a 37-mile reach of the North Fork that would approximate natural flow regimes, although flows would be greater than currently occur. There would be no need for additional channelization. This would result in favorable impacts accruing to the North Fork fishery, due to increased habitat. However, productivity per unit area or for individual fish would remain essentially the same as that of pre-project conditions, because of the continued releases of cold waters from Roberts Tunnel.

The sewage effluent exchange procedure would reduce the flows in the 6.5-mile river reach between the Strontia Springs Diversion Dam and Chatfield Lake to a minimum of 10 cfs for prolonged periods. This would essentially eliminate the fishery in Waterton Canyon.

The average flow of 3.5 miles of Straight Creek in the Roberts Tunnel System would be reduced by 14 cfs, or approximately 88 percent, annually. Wesche (1973) found that such reductions in similar streams in Wyoming resulted in a 90 percent reduction in spawning habitat and an 80 percent reduction in food producing area. Similar impacts could be expected in Straight Creek, resulting in significant adverse impacts on the fishery.

The average fluctuation in Dillon Reservoir would increase to about 74 feet under this concept. The maximum drawdown would occur during late winter or early spring when ice cover is still present on the reservoir. However, the remaining pool should be large enough to retain an oxygen reservoir sufficient to maintain fish over the winter. The pool would still be over 100 feet deep on the average prior to spring filling.

The enlargement of Gross Reservoir on South Boulder Creek in the Moffat System would provide additional water surface for fish and other aquatic life during the spring and summer. The inundation of additional land would provide for increased productivity in the reservoir from the addition of nutrients from the soils. However, the

quality of the fishery would be unlikely to improve unless remedial measures were taken to reduce the proportion of non-game fish.

The increased diversion from the Fraser River system at 89 percent of present flows would leave approximately 6 cfs immediately below the diversion point. The present aquatic community would be eliminated for a distance downstream to the point where flows would increase enough to support an aquatic community. Under ultimate development conditions, approximately 55 miles of streams in the Fraser River Basin would be depleted to essentially zero flow conditions, thereby eliminating the aquatic communtiy. Downstream from the depleted stream reaches, reduced flow conditions would result in a reduction in productivity and biomass. This latter impact would vary from stream to stream due to varying amounts of downstream tributary inflow and from year to year due to varying amounts of local in-basin runoff from precipitation. This would result in a total reduction of flow of 39,000 acre-feet annually, or an average of 54 cfs on the 19-mile reach of the Fraser River between Vasquez Creek and its confluence with the Colorado River.

An additional 3.5 miles of tributaries of the Williams Fork River would be similarly subjected to depleted flows with a consequent reduction in the productivity of fish and their food organisms. The Williams Fork River in the 5-mile reach to its confluence with the South Fork would be subjected to an average flow reduction of 18 cfs, or about 30 percent. Sufficient flow (42 cfs) would remain to maintain the same aquatic habitat.

Increased diversions from the tributaries of the upper Colorado River drainage would provide additional high quality water to the Denver metropolitan water system. This would also remove 195,000 acre-feet of diluting water from the Colorado River and would divert an average total of 24,365 tons of salt per year from the Colorado River Basin to the east slope. If these totals are hypothetically superimposed on present modified conditions, as presented in a Bureau of Reclamation report (1976), a salinity increase of 29 mg/l could be expected at Cameo, Colorado, and an increase of about 18 mg/l could be expected at Imperial Dam, Arizona. However, projected future conditions (BR 1976) include a provision for future diversions up to 235,000 acre-feet per year for municipal and industrial use in the Denver metropolitan and Colorado Springs areas. These are assumed to be developable under the terms of the Colorado River Basin Compact and are thus provided for under the terms of the Colorado River Salinity Control Act.

The additional diverted water would be stored in the potential Two Forks and enlarged Gross Reservoirs. Water of similar quality is currently being diverted to the North Fork of the South Platte River and to Gross Reservoir. No impacts on water quality due to additional diversions would result in the South Platte River and Gross Reservoir.

The use of additional water in the Denver metropolitan area would create additional sewage effluent. Due to the provisions for effluent exchange that would be implemented under Concept A, much of this effluent would be used as agricultural water. The impacts on the South Platte River downstream from metropolitan area cannot be determined until the water use is better defined.

Important and Endangered Wildlife Species. The Colorado Division of Wildlife estimates that up to 50 percent of the carryover bighorn sheep herd in the Waterton Canyon could be lost as a result of construction of Two Forks Reservoir (personal communication, DOW 1977). This loss would result primarily from construction activities within the South Platte Canyon while the dam is being built (personal communication, DOW 1977). Increased noise levels from blasting and heavy equipment traffic over a prolonged construction period (three to four years) could change migratory patterns, resulting in some displacement and eventual mortality of sheep. In addition, individual sheep mortality from illegal poaching is probable, due to increased and continuing presence of humans in the area during the construction period.

The impact of project construction on the size of the bighorn sheep herd would depend on the impacts of construction of Strontia Springs Dam and the time interval between construction of Strontia Springs and construction of Two Forks Dam. If this interval is short (i.e., two to three years) and reduction of herd size from Strontia Springs construction is great (i.e., more than 50 percent), the viability of the bighorn population in Waterton Canyon could be threatened. On the other hand, if the interval is great (i.e., more than five years) and the carryover herd is treated for lungworm, a viable population of bighorns should be maintained in Waterton Canyon.

Inundation of the South Platte study area by Two Forks Reservoir would impact the federally protected golden eagle and possibly the northern bald eagle. The value of the South Platte Canyon to eagle populations would be temporarily reduced, due to the loss of streamside riparian nesting and perching habitat and associated aquatic and terrestrial prey populations.

Elimination of riparian habitat resulting from increased streamflow depletions in the Fraser River drainage and the enlargement of Gross Reservoir could impact populations of both golden and northern bald eagles. Both species, particularly the northern bald eagle, use riparian habitat for perching, hunting, and nesting. The loss of riparian timber and decrease in terrestrial prey populations resulting from the proposed development could reduce the value of the Moffat System study area for eagle populations.

Other Game Species. Due to the potential Gross Reservoir expansion, at least 371 acres of terrestrial vegetation would be inundated and some game animals would be displaced.

Two Forks Reservoir, however, would have a major impact upon game birds and mammals of the South Platte and North Fork ecosystems. State big-game harvest records for 1974 indicate the 9 black bear, 50 elk, and about 550 deer were taken in the Two Forks vicinity (Jefferson and Douglas Counties). The loss of habitat should cause a population reduction for each of these species. The small mountain lion population of the South Platte area should be reduced by a loss of habitat and reduction of prey species in the area.

Upland game bird populations in the vicinity should be reduced or individuals displaced as a result of habitat loss and construction activities. Conversely, waterfowl populations should increase in both density and diversity after the reservoir filling begins.

A potential exists for an impact upon migratory waterfowl resulting in that some streamflows may be depleted during the migratory periods; however, the creation of Two Forks Reservoir and the stabilization of other streamflows should compensate for the total waterfowl loss resulting from flow reductions.

Endangered Species. The only river otters known to exist in the Concept A study area are the three that were introduced into Cheesman Reservoir by the DOW during the summer of 1976. The construction of Two Forks Reservoir would result in the opening of Cheesman Reservoir for public use. This action could impact State-designated essential habitat for the river otter, possibly jeopardizing the DOW introduction program in the South Platte River Basin.

The potential action could impact the nesting and hunting behavior of the pair of southern bald eagles which have been sighted near Deckers.

The federally endangered peregrine falcon could be impacted by the increased streamflow depletions in the Fraser River drainage and the enlargement of Gross Reservoir. Initially, the loss of riparian timber stands and reduction of associated terrestrial prey species could reduce the peregrine falcon's use of these areas. However, peregrine falcon hunting and nesting around Gross Reservoir may increase following the reestablishment of mature riparian timber stands along the expanded shoreline (40 to 60 years).

The inundation of 35 miles of streamside riparian habitat, particularly the 7 miles along the North Fork of the South Platte, could also impact the peregrine falcon. The historic use of the study area by this raptor species could be reduced.

Enlargement of Gross Reservoir should have no impacts on the population of greenback cutthroat trout, a federally endangered species, in the North Boulder Creek watershed (personal communication, DOW 1977).

Socio-Economic Conditions, Recreation, and Cultural Resources. The construction of Two Forks Dam and Reservoir in the South Platte River System would necessitate the relocation of the communities and settlements of South Platte, Dome Rock, and Longview. All of these are listed on the National Register of Historic Places and are within the North Fork Historic District and thus under the protection of Section 106 of the Historic Preservation Act of 1966 and would require statements of effect prior to disturbance. Twin Cedars, Oxyoke, Trumbull, and Deckers do not appear to qualify for the Register; Nighthawk does appear to qualify, and thus would be under 106 protection.

The total population of these communities is approximately 100 full-time residents and approximately 700 part-time residents. Relocations would also involve 5 miles of roads, 22 miles of power transmission lines, and 25 miles of telephone lines.

The existing recreation facilities that would be inundated by the new reservoir include 12 campgrounds, 35 picnic units, about 1/2 mile of access road, 3 miles of unsurfaced trails, and about 1 acre of parking facilities.

Impacts of the construction of the Two Forks Dam would probably exceed BLM criteria for maximum visual contrast. The nature of the impacts would be comparable to those described for similar elements of the proposed action.

Some present popular and heavily used recreation streams would be inundated by the reservoir, including about 19 miles of the South Platte River, 7 miles of the North Fork of the South Platte River, and about 9 miles of miscellaneous creeks and gulches. The present stream-oriented recreational use of approximately 240,000 annual visitor-days would be eliminated by the construction of this dam and reservoir and replaced with minimum-use reservoir-oriented recreation facilities. The present public access and use of the 9.9-mile reach of the South Platte River (Waterton Canyon) below Two Forks Dam would not be permitted.

The DWB and the U. S. Forest Service (USFS) would be subjected to substantial public pressure to more fully develop the reservoir and lands for more recreation. The reason for the pressure is the substantially unsatisfied recreation demand for water-oriented activities within the Denver metropolitan area.

Two Forks Reservoir, with its limited use recreation plan, could control crowded conditions into selected areas and would therefore

have the potential to provide some wilderness type solitude for those who want to retreat from urbanism.

The recreation plan would require strict control of the number of people entering and using the area and frequent facility repair or replacement. Without such actions, low quality recreation experiences for visitors could result. Litter and sanitation problems and rapid soil and vegetation deterioration can also be expected.

Two Forks Reservoir would tend to attract land speculators and developers because of the high quality of the setting. Communities such as Buffalo Creek and pine (parts of both are on the National Register and under 106 protection) would grow, which would place a severe burden on existing civic facilities. Second homes, rental cabins, and trailers would occupy private unzoned lands adjacent to the Two Forks right-of-way land. Those lands with outstanding vistas would draw premium prices. However, the dominance of surrounding Forest Service lands would tend to control some of the land speculation and development.

If few people fish in the reservoir, stocking may not be justified. Natural fish reproduction would not be very good because of the reservoir morphometry and limited littoral zone. Water fluctuation would also discourage natural reproduction. There could be no ice-fishing except during exceptionally cold winters when ice of sufficient thickness would form.

Although waterfowl and some game species may be attracted to water, administrative policies would discourage the development and management of land for wildlife propagation and staging. Hunting on or near the reservoir is not expected to be good and also would probably be discouraged.

Under limited use and controlled conditions, Two Forks could provide an excellent opportunity for nature study and photography. Educational institutions may be able to use the Two Forks Reservoir area as an outdoor laboratory for ecological studies.

Antero, Elevenmile, and Cheesman Reservoirs and the South Platte River from Antero to Two Forks would be operated in such a manner to retain higher water levels for longer periods of time. Concept A proposed using the west slope water first, holding the less reliable South Platte System in reserve. The maintenance of higher water levels for longer periods of time could attract recreationists. Theoretically, the larger water surface would be able to accommodate more boating than at present, when the reservoirs are drawn down more. The success in reservoir fishing would be a key factor in the increased use because the water is too cold for contact activities. Along with the possible increase in fishing would be an increase in sailing, camping, and picnicking around the reservoirs.

Cheesman would no longer be the terminal storage of municipal and industrial water for Denver when Two Forks is in place. This means it could be opened for more recreation activity, including boating, fishing, water skiing, picnicking, camping, group camping, hiking, nature study, and limited swimming. The amount of use would be limited by available facilities and administrative policies. Its full recreation potential would be less than the statistics previously shown in Table 8-5.

The cultural and social characteristics of the local population remaining in the area would be altered. Many people required to move would find relocation difficult to accept and an incalculable personal loss.

The beneficial social effects in the Upper South Platte area would include increased real income during construction, primarily to semi-skilled and unskilled minority workers. Following construction, other persons would benefit financially through increased recreation oriented economic activities. Management of the recreation and fish and wildlife facilities would upgrade health and safety conditions.

Construction of Two Forks Dam and Reservoir would inundate roughly half of the land area of the North Fork Historic District (National Register of Historic Places, October 9, 1974).

These historic components would be destroyed outright through construction and inundation, or relocated. While certain types of structural ruins may actually be preserved by covering waters, the inundation would have an overall negative effect on historic properties within the high water boundary of the reservoir (Feldman 1976 and Emrick 1976). Evaluation of impact on historic components above the high water line is as follows:

1. Such components would have their setting drastically altered in terms of topography, vegetation, and related components.

2. Visitors could cause damage to those components remaining above high water lines.

3. Alternatively, a well managed cultural resources program could provide protection for those components remaining above high water line and provide a valuable educational/recreation experience for visitors to the reservoir. This possibility is minimized because most of the structures adaptable to interpretation are below the high water line.

In summary, the historic losses would be greatest in that portion of the Two Forks Reservoir that would inundate roughly half of the North Fork Historic District.

Recent archaeological investigations within the South Platte impact area have provided a base for further research into the nature of early man's existence in the region. This has been articulated in a series of hypotheses about early man's activities in the area and about broader questions of cultural process. Mitigation of these resources through systematic excavation and analysis would provide an excellent opportunity to thoroughly study these questions.

Construction of Two Forks would destroy the physical aspects of the research base necessary to enlarge upon these hypotheses. Despite this destruction, it is questionable whether destruction by project construction would have an overall negative effect upon the resource. Private construction and unauthorized removal and/or destruction of antiquities make long-term survival of these resources questionable. The choice essentially becomes one of systematic beneficial removal through mitigation, or nonproductive removal through nonfederally controlled construction and/or "pot hunting."

Further studies would be required to more properly assess the loss in scientific, educational, and monetary terms.

Construction of the Straight Creek facilities in Roberts Tunnel System would not require relocation of property or people. Since the diversion conduit would be underground, adverse impacts to the natural scenic value of the area would be minimized.

The construction work force would probably live in the Dillon area, causing temporary increased demands on community services.

Since the average flow of Straight Creek would be reduced 88 percent, the fishery quality below the diversion structure would suffer; however, the beaver ponds and the upper part of the creek should still be good fishing for brook trout. Although less water would be entering the Blue River below Dillon Dam, the remaining flows should continue to provide a stockable stream for rainbow, brown, brook, and cutthroat trout. The fishery should remain fair to good (Kelly 1975), and the fishing pressure should not change because of Concept A development.

Green Mountain State Park, which includes Green Mountain Reservoir and the surrounding terrain, received approximately 165,000 visitor days use in 1976. Seasonal fluctuations in the pool level would adversely affect recreation use of the reservoir. The actual losses in visitor days that would result cannot be quantified.

Impacts of the construction of Straight Creek facilities would probably exceed BLM criteria for maximum visual contrast. The nature of the impacts would be comparable to those described for similar elements of the proposed action.

Depending on the degree and time of year of drawdown, the recreation use of Dillon Reservoir could decline from present visitations. Less surface acreage would be available for water-oriented recreation activities (e.g., power boating, sailing, and fishing) during late summer and early fall.

Exposed reservoir bottom land would contrast with the surrounding conifer-aspen forests, detracting from the visual qualities of the Dillon Reservoir area.

The reduction in recreation activities on the reservoir and the increased exposed bottom lands could depreciate the value of newly constructed condominiums which depend heavily on the Dillon area's aesthetic and recreation qualities. This would make some developments difficult to sell and discourage future development of similar type units.

No significant impacts to known historic or prehistoric resources are anticipated in the Straight Creek or Dillon Reservoir impact areas. However, further studies will be required within these areas and an E.O. 11593 survey would be required. Streams such as Straight Creek and the Blue River that would experience decreased annual flow would have to be surveyed after the project is in operation. Such a decrease in flow could cause some cultural sites to be exposed to nonalluvial weathering and destruction due to increased visitor access. There is no economical way to survey and/or mitigate these latter sites before the project is in operation.

Gross Reservoir enlargement in the Moffat System would not require relocation of real property, roads, or people.

The temporary influx of construction forces in the area would have minimal or no impact on services provided by local communities.

Impacts of the enlargement of Gross Dam would probably exceed BLM criteria for maximum visual contrast; the nature of the impacts would be comparable to those described for similar elements of the proposed action.

The increased water diversion by the western slope collection system would significantly reduce flow and asssociated riparian habitat on about 55 miles of high mountain streams. This would adversely impact the scenic, cultural, and recreational value of these streams.

The Williams Fork-Fraser River Systems would have their drainage flows reduced 30 percent and 90 percent, respectively. There are many good holes and riffles producing one of the better fly-fishing areas for rainbow and brook trout. The Fraser River and its tributary flow would be reduced from 60 to 65 cfs. The associated fair-to-good

fishing would be lost. Both streams contribute to the quality of other recreation experiences. The quality of hiking, nature study, horseback riding, and picnicking would be degraded.

Enlargement of Gross Reservoir could increase the recreation potential of the reservoir. Improved fishing would attract more fishermen, provided the non-game fish population is reduced. Heavy use of the recreation facilities could result from an improved fishery. Gross Reservoir could expand its present use from shore fishing only to camping, picnicking, and possibly boating. Shore fishermen could continue to have access to the reservoir but might be discouraged by the great increase in muddy shores resulting from frequent drawdowns.

Flows in South Boulder Creek would increase from 72.5 to 144.5 cfs. However, this additional volume of water would not improve the fishing between the Moffat Tunnel's east portal and Rollinsville because there is no way to stock the stream (Kelly 1975); the present fishery is poor. No impacts to historical or prehistorical resources are anticipated within the Gross Reservoir and west slope collection system impact areas. However, compliance with E.O. 11593 survey will be required in the area of the increased waterline.

As discussed under the Roberts Tunnel system, decreased streamflows could cause some cultural sites to be exposed. Increased streamflows, for example in South Boulder Creek, could also inundate cultural resources. There is no economical way to survey and/or mitigate these potential losses before the project is in operation.

Concept B

General

Concept B, shown on Map 8-2 (located at the end of this chapter), would be the same as Concept A, except that the existing Corps of Engineers Chatfield Dam and Lake would be enlarged to accommodate east slope municipal and industrial terminal conservation storage in lieu of building the potential Two Forks Dam and Reservoir for this purpose.

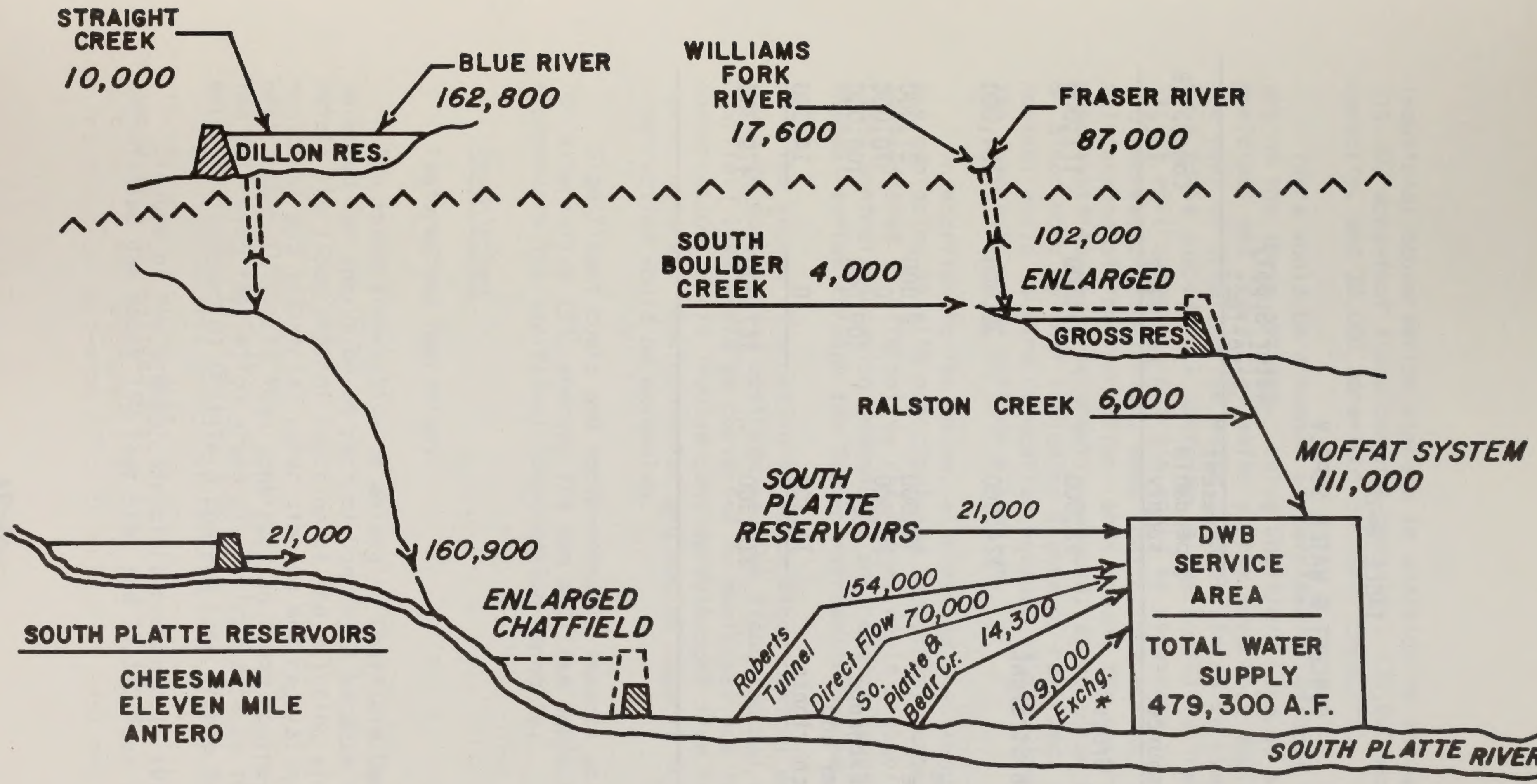
The features and plans of Concept B, like those of Concept A, would be enlargement of the existing Gross Dam and Reservoir, additional Blue River water diversion facilities (Straight Creek collection system), the acquisition of new water rights, and the exchange of treated Denver sewage effluent for agricultural water.

The description of the like features, their operations, and environmental impacts are given under the discussion of Concept A; therefore, they are not repeated here.

The combination of Concept B features and operational modifications would provide about 479,300 acre-feet total of raw water to the Denver metropolitan area, as shown on Figure 8-5 and Table 8-10.

In Concept B, Chatfield Dam and Lake would be used as the principal east slope facility for storing municipal and industrial water for treatment by the Foothills Treatment Plant and eventual use in the Denver metropolitan area. The enlargement of Chatfield Dam and Lake would also provide for flood control downstream of the structure, and minimal recreation facilities would be constructed. Congressional authorization would be required to modify the existing Chatfield Dam and Lake to provide for new or revised project operations or functions.

About 305,000 acre-feet of storage capacity would be adequate to regulate the South Platte and Blue River flows as well as store and regulate agriculture water purchased and exchanged for treated sewage effluent from the Denver metropolitan area. In arriving at this concept, three options for using Chatfield were considered. These were: (1) eliminating the present flood control capacity in Chatfield Lake completely and drastically reducing the surcharge capacity, using this space for municipal and industrial conservation storage, (2) replacing the flood control storage with municipal and industrial conservation storage and constructing dams upstream on Plum Creek and the South Platte River for flood control purposes, and (3) enlarging Chatfield Dam and Lake to include 305,000 acre-feet of municipal and



*Exchange includes acquired water rights

NOTE: ALL NUMBERS IN ACRE-FEET

WATER SUPPLY SCHEMATIC

CONCEPT B

FIGURE 8-5

TABLE 8-10

CONCEPT B WATER SUPPLY

Feature and source	Water Supply acre-feet: Present dependable supply	Increase	Concept B Total
Moffat system with Gross enlargement	92,000	19,000	111,000
Roberts Tunnel with Straight Creek	124,000	30,000	154,000
South Platte System			
Reservoir Storage	12,000	9,000	21,000
Direct Flow	70,000	0	70,000
Acquisition and Exchange	--	109,000	109,000
South Platte River and Bear Creek Ditch rights	14,300	0	14,300
Total	312,300	167,000	479,300

industrial conservation storage in addition to the existing 215,000 acre-foot flood control capacity, 120,000 acre-foot surcharge capacity, and 20,000 acre-foot sediment capacity.

There would be a number of detrimental effects associated with any of the above options. Using Chatfield Lake as a terminal municipal and industrial water supply reservoir would greatly increase the cost of treating the water. Water stored in Chatfield Lake would have to be pumped back upstream to the Foothills Treatment Plant. Strict environmental controls would be necessary to handle waste from the recreation facilities, weed control operations, and general maintenance of the recreation lands around the reservoir. Recreation opportunities would be greatly reduced, as no motor boating, swimming, or other body contact including highways, railroad, powerlines, and houses, would require relocation because of the wide fluctuation of the reservoir water surface elevation.

In addition to the above, eliminating the flood control capacity and replacing it with municipal and industrial conservation capacity, as suggested in alternative (1) above, would probably necessitate new flood control operation procedures and require greatly increased channelization through the Denver metropolitan area.

The second alternative in which flood-control dams and reservoirs would be constructed upstream and the flood-control capacity in Chatfield Lake would be converted to municipal and industrial conservation, would involve considerable cost from the construction of new structures. Environmental and social impacts from the construction would be extensive.

Significant costs and socio-economic impacts would also result for alternative (3), whereby the dam and lake would be enlarged to accommodate the additional conservation capacity.

Description

Features and Operations

The third alternative of enlarging Chatfield Dam and Lake was selected for inclusion as part of Concept B because it would still retain the flood control function of the existing structure, provide municipal and industrial water storage and regulation, and have fewer environmental impacts than constructing flood control dams upstream. The following tabulation gives statistical data on the present and enlarged (Concept B) Chatfield Dam and Lake (Table 8-11).

Closure of the present structure occurred in 1973. It is an earthfilled dam about 150 feet high and 13,340 feet long. The

TABLE 8-11

CHATFIELD DAM AND LAKE

	Existing	Enlarged
Total capacity (acre-feet)	355,000	660,000
Surcharge capacity (acre-feet)	120,000	120,000
Flood control capacity (acre-feet)	215,000	215,000
Conservation capacity (acre-feet)	0	305,000
Sediment capacity (acre-feet)	20,000	20,000
Maximum water surface elevation (feet msl) 1/	5,522	5,563
Top of conservation (feet msl) 1/	5,426	5,517
Area at top of conservation (acres)	1,150	5,826
Additional rights-of-way (acres)	____	3,500
Top of dam (feet msl) 1/	5,528	5,570
Crest length (feet)	13,340	29,000 2/
Height of embankment (feet)	150	192
Additional inundated streams (miles)		
South Platte River	____	5
Plum Creek	____	3
Deer Creek	____	1
Shoreline (miles)	10	26
Conservation pool fluctuation (feet)	4	91

1/ msl = mean sea level.

2/ Includes 12,000 foot dike section.

proposal to add about 305,000 acre-feet of conservation space would require adding 42 feet to the height and 3,660 feet to the length of the dam. The total reservoir capacity would then approach 660,000 acre-feet. Present assigned capacity for sediment, flood control, and surcharge would remain unchanged. The enlarged reservoir would require an additional 3,500 acres of rights-of-way. About 100 acres of land would also be required to construct underground conduits and the pumping plant to transport water from Chatfield to the Foothills Treatment Plant.

Enlargement of Chatfield Dam and Lake would require major relocations of existing real property and inundation of several thousand acres of lands adjacent to the reservoir now being subdivided for residential and light industrial uses. Relocation would include the community of Waterton and the DWB Kassler water treatment plant, approximately 9 miles of the Highline Canal, 4.6 miles of State Highway 75, 1.5 miles of Deer Creek Canyon Road, and 4 miles of county roads. In addition, relocation of railroads, transmission lines, natural gas lines, and water supply facilities would be required.

A pumping plant and buried conduit would be necessary to convey water from Chatfield Lake to the proposed Foothills Treatment Plant. The pumping plant would be located on the right embankment of Chatfield Dam and would have a capacity of 750 cfs with the pool at the minimum elevation of 5,426 feet. Two parallel 84-inch-diameter conduits would transport the pumped water 6 miles southwest to the Foothills Treatment Plant. The pumping plant would be designed for a total dynamic head of 550 feet and would require a maximum electric power demand of 55 megawatts. The parallel conduits would pass beneath the enlarged Chatfield Lake for a distance of approximately one mile.

The enlarged reservoir would regulate waters from the Blue and South Platte Rivers, provide for better use of the DWB direct flow rights, agricultural water rights purchased, and agricultural water obtained in exchange for treated sewage effluent from the metro sewage plant. The reservoir would reach its maximum surface elevation each June, followed by a steady decline to a minimum elevation sometime in December. The water level would fluctuate between elevations 5,517 and 5,485 annually and could drop to 5,426 during periods of extreme droughts or floods.

Chatfield Lake would store water originating in the South Platte Basin as well as west slope water transported through the Roberts Tunnel. An average of 160,900 acre-feet annually would be diverted through Roberts Tunnel and conveyed by the North Fork of the South Platte River. Flows downstream of Strontia Springs Dam would be dependent on the operation of the Foothills Treatment Plant. Flows would be at least equal to those necessary to meet downstream senior

water rights not involved in exchange; generally, flows would be greater, as waters would be stored in Chatfield Reservoir.

Raw water would be diverted from the lake to a pumping plant and from there to the Foothills Treatment Plant, located about 6 miles southwest of Chatfield Dam. The pumping plant would be operated in one of two ways: (1) to supply, as a base load plant, a constant supply of water to the Foothills plant for treatment, or (2) to deliver water to a peaking facility, pumping large quantities of water from May through September to meet the peak water demands.

Chatfield Lake contains water of relatively high quality (Corps of Engineers 1974). The water quality of the South Platte River is monitored at the Kassler Water Treatment Plant by DWB. Results of this monitoring show that the water is within the water quality criteria for raw water for municipal use (DWB 1973, 1974, 1975, and 1976).

As with Concept A, restrictions on public use including elimination of body contact sports and limitation of boating to nonpower craft would be necessary to protect the quality of the water. Sewage treatment facilities for minimum base recreation facilities would be required to eliminate contamination of water. Insecticide and other chemical treatments within the immediate area would be prohibited. Strong anti-litter control measures would be enforced.

Under Concept B, Cheesman Reservoir would continue to provide terminal storage for Denver's South Platte River water supply. Maximum water storage in the existing South Platte River reservoir system, Cheesman, Elevenmile Canyon, and Antero, would be maintained in the highest reservoir whenever possible, to optimize yield on a long-term basis. Minimum river releases below each reservoir would be provided to meet senior downstream water rights. Diversion of flows into the North Fork channel would be coordinated with natural flow conditions to minimize degradation and flooding.

Present Environment

The description of the environment for the Gross Reservoir enlargement, Williams Fork-Fraser River collection system, and Straight Creek-Dillon Reservoir collection system are included under Concept A and will not be repeated for Concept B.

Soils and Terrestrial Resources. A belt of hogbacks divides the South Platte River Basin into two geologic regions. The region to the west of the steeply tilted ridges of sedimentary rocks (sandstones, shales, limestones) is primarily underlain by igneous and metamorphic rocks, including granites, schists, and gneisses. The region to the east of the hogbacks is underlain by deposits of compact sands, silts, and clays (Corps of Engineers 1974).

The South Platte River valley in the vicinity of Chatfield Lake has been built up through the deposition of alluvial materials, mainly sands, gravels, and sandy clays derived from the weathering and erosion of the parent materials in the foothills and mountains to the west. On the east slope of the valley, the materials consist chiefly of sands and gravels with an occasional layer of silty or clayey sand. The overburden on the east slope is approximately 50 feet thick (Corps of Engineers 1974).

A more detailed description of the general soil types in the Chatfield Lake vicinity, based on the Soil Conservation Service's Range Site Descriptions, is included for Concept A.

The shortgrass plains ecosystem is predominate in the vicinity of Chatfield Lake. Intermittent watercourses, known as arroyos, crisscross the plains, providing sheltered habitat for the growth of shrubs and forbs. Perennial drainages, including the South Platte River and its primary tributaries, Plum, Bear, Clear, Sand, and Cherry Creeks, support characteristic riparian stands of cottonwood and willows.

Blue grama and buffalo grasses are the principal vegetative constituents of the shortgrass ecosystem. Growing no more than 16 inches tall, the shortgrasses form relatively shallow but very dense sods. The tawny swards of buffalo grass and bright green clumps of blue grama are liberally mixed with other short and mid-grasses including wheatgrasses, little bluestem, June grass, prairie dropseed, muhly grass, and curly-leaved sedges. Cheat grass, a common invader species around Chatfield Lake, is indicative of severly deteriorated range conditions. The plains uplands are sprinkled with rabbitbrush, fringed sage, yucca, and prickly pear cactus. An assortment of wildflowers, mainly white- and yellow-flowered composites, add variety to the rolling landscape.

The arroyos support relatively dense growths of shrubs and forbs including chokecherry, gooseberry, currant, saltbush, compass flowers, dotted gay feather, penstemon, aster, goldenrod, locoweed, coneflowers, and bee plant.

Riparian vegetation in the study area consists primarily of plains cottonwood, several species of willows, alders, an occasional box elder, and a diverse understory of shrubs and forbs. The exception is Plum Creek which has limited understory due to overgrazing and the scouring effect of spring floods (Corps of Engineers 1974). A dense grove of large plains cottonwood trees is located along the South Platte River on the southeastern and southwestern sides of the existing flood pool boundaries. This flood plain forest is interspersed with expanses of open grassland. Other woody plants found in this grove include lanceleaf cottonwood, box elder, and several species of willows. Understory vegetation consists

primarily of poison hemlock, Canadian thistle, slender wheatgrass, western snowberry, golden currant, woodbine, and wild grape. Slender wheatgrass, Canadian thistle, smooth brome, common cattails, bulrushes, and a variety of sedges dominate the vegetative complex of the forest clearings adjacent to the lake (Corps of Engineers 1974).

In the study area, riparian habitat along the south Platte River and its tributary streams supports limited populations of mule deer, upland game, and furbearers. However, the availability and quality of wildlife habitat around Chatfield Lake has suffered from the surrounding suburban development (Corps of Engineers 1974).

The cottontail rabbit is the most common upland game mammal. A few mule deer have been observed in the study area. The Fish and Wildlife Service (1966) reports that small populations of beaver, mink, and muskrat are also present. Neither hunting nor trapping are permitted within the Chatfield Lake boundaries due to the proximity of the Denver metropolitan area.

Other mammal species known to inhabit the study area include the white-footed mouse, black-tailed prairie dog, long-tailed weasel, meadow vole, red fox, raccoon, and skunk.

The most abundant game bird species in the area is the mourning dove (FWS 1966). Various ducks and geese also utilize Chatfield Lake and the South Platte River in the study area during fall and spring migratory periods.

The flood plain forest along the southwestern arm of Chatfield Lake supports 40 nesting species of birds. Members of the Denver Field Ornithologists have made regular field counts in the study area for several years. Avian population densities as high as 684 birds per 100 acres have been calculated (Corps of Engineers 1974). Such densities equal those of the highest populated avian habitats anywhere in the country (Corps of Engineers 1974). These high population counts are directly attributable to the abundance and diversity of nesting and feeding habitat in and around the cottonwood grove and the relative scarcity of similar habitat in the vicinity (i.e., 5-mile radius) of Chatfield Lake.

Owls, hawks, yellow warblers, redstarts, vireos, and kingbirds nest high in the cottonwood canopy. Orioles, goldfinches, robins, and peewees nest in the middle elevations of this forest. Towhees, chats, MacGillivray's and Virginia's warblers, catbirds, and scrub jays nest in the shrubby understory. Pheasants and meadowlarks nest in the open grassland areas. Birds which nest in holes in dead trees include the flicker, downy woodpecker, chickadee, house wren, starling, and screech owls.

Regular visitors to the grove, but not nesting there, are the killdeer, common nighthawk, belted kingfisher, barn swallow, black-billed magpie, and lazuli bunting. Irregular visitors are the violet-green swallow, cliff swallow, catbird, Audubon's warbler, Wilson's warbler, common grackle, red-winged blackbird, house finch, chipping sparrow, white-crowned sparrow, and song sparrow (Corps of Engineers 1974).

Aquatic Resources. Chatfield Lake is managed as a mixed warm and cold water fishery supporting largemouth bass, bluegills, crappies, and trout (Corps of Engineers 1974). The fishery in Chatfield is expected to be maintained entirely with hatchery-reared fish. There are also provisions for put-and-take fisheries in ponds created by sand and gravel operations in the upper end of the reservoir (Corps of Engineers 1974).

The aquatic resources of the South Platte River, North Fork of the South Platte River, and Colorado River have already been described in the discussion for Concept A.

Important and Endangered Species. The previously described forest of plains cottonwood trees within the southern boundary of the Chatfield Lake project area contains a great blue heron (Ardea herodias terganzi) rookery. The presently active rookery covers approximately 27 acres.

There are golden eagle nests in the vicinity of Chatfield Lake. Bald eagles may also utilize portions of the study area during migratory periods, but none are known to nest there (personal communication, DOW 1977).

No federal or state threatened or endangered mammals are known to exist in the study area (DOW 1976).

The endangered peregrine falcon has been observed in Jefferson and Douglas Counties and therefore may be found in the Chatfield Lake vicinity. The state, however, does not list the study area as essential hunting or nesting habitat for the peregrine falcon (DOW 974).

The discussion of the status of threatened or endangered amphibians, reptiles, and plants in Colorado provided for Concept A is also applicable to all aspects of Concept B.

Recreation, Socio-Economic Conditions, and Cultural. The area around the existing Chatfield Dam and Lake is the fastest growing recreation complex in the Denver metropolitan area. Ultimately, the lake and surrounding public use facilities are expected to provide recreational opportunities for over two million visitors annually.

As presently planned (Corps of Engineers 1972), the minimum multi-purpose (elevation 5,426 feet) will have a surface area of 1,150 acres for water-oriented recreational activities. Thus water-use recreation will be divided into three separate areas on the lake.

1. Motorless boating area: sailing, bird watching, hand-powered boats, fishing and swimming.

2. Open boating area: power boats, water skiing, and fishing.

3. Wakeless boating area: 5 hp or less sailing, fishing, hand-powered boats, and swimming.

The ultimate land use plan (Corps of Engineers 1972) for those areas surrounding Chatfield Lake allocates recreational use in one of four separate categories. These categories are (1) day use; (2) overnight use; (3) natural or environmental study use; and (4) open space.

Day use activities include picnicking, swimming and water skiing beaches, shoreline fishing, hiking, bicycling, playgrounds, boating, and sightseeing.

Overnight use areas will be used for trailer and group camping and for tent and walk-in type camping.

Areas that are ecologically worthy of preservation, enhancement, or interpretation will be used for natural or environmental study. These areas will remain relatively undisturbed with only minor development of trails to accommodate public use.

Open spaces are scenic areas, too rugged for development, and the buffer zones separating public highways from developed recreation areas. Minimum trail development will be provided for public use in these areas.

The existing visual environment for this concept is the same as described in Chapter 2, and in Chapter 8, Chatfield Alternative.

Bordering Chatfield Lake to the north and northwest are rapidly expanding residential complexes, which will soon surround the government land occupied by the reservoir right-of-way. To the south and west are industrial complexes and other homes, with farmlands still maintaining a precarious foothold. It appears that the remaining land will be occupied by industry and residential developments in the near future.

Two major industrial complexes are located west of the reservoir; Johns-Manville and Martin-Marietta. Modern highways provide easy

access to the reservoir; railroad lines bisect the landscape; both are intermingled with the remaining, but diminishing, agricultural culture that once flourished here.

Two main studies have been completed for the historic cultural resources in the area in and around Chatfield Lake (Corps of Engineers 1972 and Emrick 1976). The first deals with prehistoric resources and the second with historic resources.

The Corps of Engineers' studies done in 1965, 1966, and 1969, located 21 prehistoric sites with identifiable artifacts. Of these, 17 were within the maximum pool level of the present lake. Of the four outside this line only one is deemed significant. This is K:12:14, an apparent Woodland site which was characterized by circular stone rings (probably tee-pee rings), a number of hearths, and a number of food procurement and preparation implements. In addition to this site, other archaeological and paleontological remains have been unearthed during the past 30 years. Notable among these are the Lamb site (K:8:49), where a mammoth skeleton and a disassociated Yuma type point were found (Wedel 1961, 1962, 1963, and 1964), and a fossil mammoth skull found during construction of the Chatfield Dam. This latter find is estimated to be between 120,000 and 200,000 years old. Based on the scanty evidence available, the area seems to have a human occupation of roughly 6 to 10 thousand years.

Emrick's 1976 survey located two historic sites that could be affected by the Chatfield expansion. One is outside the present high water line of Chatfield Lake and inside the projected high water line for the proposed expansion. This is a portion of the Highline Canal, construction of which began in 1881. The second is the village of Waterton (formerly Wye), which originally was a station on the Colorado and Southern Railroad Line. It was later used to house workers for the Cheesman Dam construction. The village is within the maximum pool level of the present Chatfield Lake; the expansion would inundate it.

In addition to those properties cited by Emrick, there are two small farmsteads and a one-room schoolhouse located in a small valley in the Deer Creek area within the conservation pool of the potentially enlarged reservoir. These structures date from about 1849. One of the two farmsteads is the Hildebrand Ranch, which is listed on the National Register of Historic Places.

Temporary construction access roads would be required to haul borrow material from south of the dam. Most borrow materials, including selected earth embankments and sands and gravels, could probably come from within the present Corps of Engineers' reservoir takeline (outermost boundaries of land that must be acquired for the reservoir). These construction activities within the present

reservoir area would cause a major impact for planned recreation facilities and use of Chatfield Lake.

Temporary unavoidable soil erosion from borrow areas and contractor haul spills could increase lake turbidity, which would reduce the quality of fishing as well as other water sport activities. Owing to the growing urbanization and human influence adjacent to the present reservoir takeline, the displacement of the remaining terrestrial wildlife should be minimal.

Construction of the pumping plant and underground conduit required to convey municipal and industrial water from Chatfield Lake to the Foothills Treatment plant would disturb approximately 100 acres. The pumping plant would be located on the east embankment of the southeastern arm of the existing lake, primarily within the confines of an existing transportation and utility corridor. Presently, rights-of-way used for Denver and Rio Grande Western and Atchison Topeka and Santa Fe railroad lines, the Highline Canal, and a high voltage transmission line pass within 1/4 mile to the east of the potential plant site. Due to this surrounding development, the amount of native terrestrial vegetation and associated wildlife in the potential construction area is limited.

The water conveyance system would consist of 6 miles of two parallel, 84-inch-diameter buried conduits. One mile of this length would extend from the pumping plant, under the enlarged lake surface, to the opposite shoreline of the southeastern arm of the lake. From there, the structure would cross approximately 5 miles of shortgrass plains in a southerly direction, ascending 400 feet to the potential Foothills Treatment Plant near the existing Aurora Rampart Reservoir. This construction would require a maximum right-of-way width of 50 feet. The vegetative community would be temporarily disturbed by this action. Also, terrestrial wildlife would be displaced by construction activity and habitat destruction. The expanses of similar habitat (i.e., native shortgrass plains), both to the east and west of the potential construction corridor, should facilitate successful relocation of displaced animals. Following construction, the quality of the disturbed habitat could be restored by contouring and replanting of native vegetation.

Enlargement of Chatfield Lake would require the relocation of the existing Kassler Treatment Plant and 9 miles of the Highline Canal, 4.6 miles of Colorado Highway 75, 1.5 miles of the Deer Creek Canyon road, 4 miles of miscellaneous county roads, and 2 miles of high voltage transmission lines. Construction rights-of-way required for relocations would vary in width from 50 to 300 feet. As the specific nature of these relocations has not yet been determined, impacts to terrestrial vegetation and wildlife are difficult to determine. However, any relocation schemes would result in some disruption of habitat and displacement of animals. The degree of impact could be

reduced by efforts to restore disturbed areas to natural conditions (e.g., recontouring, revegetation).

Changes in historical steamflow regimes could impact the abundance and diversity of riparian habitat along the South Platte River. The degree of impact would be contingent on timing and volume of flow increases.

Following construction, any trenches and borrow areas above the top of the conservation pool would be backfilled and shaped to blend with the natural surroundings.

Analysis

Environmental Impacts

The impacts associated with the Roberts Tunnel and Moffat Systems (west slope) are the same as described for Concept A. The impacts covered here (Concept B) are those involving enlargement and operation of Chatfield Dam and Lake to provide terminal municipal and industrial regulatory storage for the DWB's South Platte River system.

General. The following discussion is related to temporary construction impacts only. Long-term impacts follow under appropriate headings.

Construction and enlargement of Chatfield Dam would result in temporary, localized deterioration of air, noise, and water quality. Increases in noise and dust levels would be most disturbing to nearby residents. Soil erosion would increase turbidity in surface water flowing from the construction areas. Increases in dust, hydrocarbons, nitrogen oxide, and carbon monoxide would result from the operation of heavy construction machinery.

Major disruption of both vehicular and railroad traffic would occur during construction. Temporary detour routes for State Highway 75 and U. S. Highway 85, and for the Denver and Rio Grand Western, and Atchison Topeka and Santa Fe Railroads would be required around the construction (enlarged) area of the dam.

Terrestrial Resources. The surface area of Chatfield Lake at the maximum conservation pool elevation would be increased from 1,150 acres to 5,826 acres; this enlargement would inundate at least 4,676 acres of existing terrestrial vegetation and associated wildlife habitat. In addition, this action would flood riparian vegetation along 5 miles of the South Platte River, 3 miles of Plum Creek, and 1 mile of Deer Creek.

The primary vegetative types affected would be the shortgrass plains of the existing lake uplands and the cottonwood-willow association of the riparian and flood plain areas.

Terrestrial wildlife would be displaced by the potential action. If similar habitat is available within a reasonable migratory distance (i.e., according to the particular species being considered), displaced wildlife should be able to successfully relocate. Animals which cannot successfully relocate could perish. Two factors must be considered in determining the degree of impact to terrestrial wildlife. With the exception of avian fauna, wildlife populations in the Chatfield Lake vicinity have been reduced by the surrounding suburban and industrial development. The impacts on sheer numbers of wildlife should be less than would occur if the existing lake was situated in a more rural setting. However, the encroachment of civilization has also reduced the availability of adjacent similar habitat. Thus, relatively speaking, the wildlife that are displaced should have difficulty relocating.

Before inundation, the majority of trees comprising the flood plain cottonwood forest along the southwestern arm of the lake would be cut and removed. This action would eliminate part of one of the most densely populated avian habitats in the country (Corps of Engineers 1974). Due to the lack of similar haitat within a 5-mile radius of the study area, displaced birds, particularly nesting species, would have difficulty relocating. Affected avian fauna which can migrate over long distances and adapt to varying habitat conditions should be able to successfully relocate.

During normal water years, the reservoir surface would fluctuate 32 feet between elevation 5,517 and 5,485. The general operational pattern would provide for a maximum water surface elevation sometime in June, with a steady decline to a minimum water surface elevation in December. During periods of extreme drought or heavy spring runoff, the reservoir surface could fluctuate as much as 91 feet (between elevations 5,517 and 5,426) during any given year.

These potential changes in the range of conservation pool fluctuation, from the existing annual average of 5 feet, would promote the formation of extensive mudflats along the 26 miles of shoreline of the enlarged lake. Development of terrestrial riparian vegetation within these mudflats should be limited to annual weeds and grasses. Growth of perennial forbs, shrubs, and trees should be restricted by water level fluctuations, thus reducing the abundance and diversity of terrestrial wildlife populations in the Chatfield Lake vicinity. However, the proposed operational pattern could improve waterfowl nesting and feeding habitat within the lake boundaries.

Aquatic Resources. Under this concept, diversions would take place in the same streams as in the previous concept. Impacts in the collection system would be identical to those previously described.

Under Concept B, water that could not be diverted at Strontia Springs would pass down Waterton Canyon to Chatfield Lake. The presently productive stream fishery of the Upper South Platte Canyon above the confluence would remain as it is. However, the fishery in Waterton Canyon would provide little or no return. As it stands now, this section of the river is difficult to fish during high water (International Engineering Corporation 1973). With increased flows, this situation would be aggravated over a longer period of time.

An enlarged Chatfield Lake would provide a significant warm water fishery during its initial year of operation because of the high biologic productivity from nutrients released from inundated soils. After reaching peak productivity and leveling out at a lower-than-peak-productivity, it would be necessary to stock the reservoir to meet the heavy fishing pressure.

Cheesman Reservoir would still provide terminal storage for Denver's water supply; therefore fishery management would not be required.

Under this concept, the diverted water would be identical in both quantity and quality, as was described under Concept A. As a result, the expected increase in salinity in the Colorado River would also be the same.

The water diverted for the Foothills Project will proceed through Dillon Reservoir, the Roberts Tunnel, and be stored in Chatfield Lake. The diverted water is of high quality, and would probably result in a relatively minor change in the water quality of the reservoir. A change would be a slight improvement in already high quality water. Therefore, it would still be suitable for municipal use with standard treatment technology.

The impact on the water quality of the South Platte River downstream from the metropolitan area would be about the same as under Concept A.

Important and Endangered Species. Enlargement of Chatfield Lake would eliminate the great blue heron rookery located in the upstream portion of the present multipurpose pool along the South Platte River. Prior to inundation, the cottonwood trees in the rookery would be cut and removed from the study area; this action would result in the loss of some members of this heron population.

The cutting of cottonwood groves and inundation of other riparian habitat could also reduce the value of the study area for nesting and hunting populations of golden eagles and peregrine falcons.

Recreation, Socio-Economic, and Cultural. Chatfield Lake would have its capacity increased by 305,000 acre-feet. The lake size would increase from 1,150 to 5,826 surface acres at the top of conservation pool. The lake shoreline would increase from 10 to 26 miles, and an additional 3,500 acres of land would be acquired.

With full recreation development, as presently planned, Chatfield's 1,150 surface acre pool and surrounding land use facilities are expected to draw 2 million visitors annually. The larger pool of 5,826 surface acres and 26 miles of shoreline could accommodate substantially more visitors. The visitation can only be considered potential, because the proposed lake administration is to provide minimum recreation opportunities. The Corps of Engineers and DWB could expect to receive considerable pressure from local residents to lift recreation use restrictions on an enlarged Chatfield Lake.

The primary reduction in recreation activities, in utilizing an enlarged Chatfield Lake as a terminal municipal and industrial storage facility, would be those associated with water use. The main restrictions would apply to motor power boats, water skiing, and swimming. Other water use activities such as sailing, hand-powered boating, and fishing would not be affected by restrictions, and these activities would tend to increase at a rapid rate. This situation would require strict control of the number of people using the lake surface. Without strict controls and enforcement, litter and sanitation problems can be expected.

Related recreational land use activities and developments as described earlier for the present development could continue as planned. The existing recreation facilities would need to be relocated. Outhouse vaults would need to be sealed and new vaults built for any relocated facilities. Boat launch ramps would be extended. Campgrounds, picnicking pads, and plumbing would be inundated. The overhead shade shelters would need relocating. Entrance and administrative buildings would also need relocating. Those facilites lost to inundation can be easily replaced; therefore, the losses are not considered a significant impact.

Enlarged Chatfield would usually have an annual fluctuation of 32 feet. The drawdown would inhibit fishing and shoreline activities during the latter part of the summer peak season. An extreme drawdown of 91 feet would reduce the number of participants in all activities, and the quality of experience would be degraded.

The volume of water coming down through the South Platte Canyon from the North Fork-Roberts Tunnel-Dillon System and the South Platte

System would discourage stream fishing. The canyon would be unsuitable for fishing during periods of high flows.

The "chutes," swimming, tubing, canoeing, kayaking, and associated camping and picnicking would remain available to recreationists because it is upstream from the North Fork confluence. Biking, hiking, and motorcycling could also continue.

The enlargement of the existing Chatfield Dam and Lake would have both negative and positive impacts on the social, cultural, and economic aspects of the local community and to a less extent on the Denver metropolitan area.

Construction activities would result in dust, noise, traffic congestion, and other disturbing influences. Certain light industry and residential property west and south of the present reservoir would be inundated or relocated. Powerline structures and other services would be temporarily disrupted during the construction period.

Increasing the size of the Chatfield Dam and Reservoir will increase the visual impacts that have already occurred as a result of the dam's initial construction.

The inundation and displacement of local facilities as a result of the enlarged lake and right-of-way could be mitigated by reconstruction, relocation, and reimbursement. Kassler Treatment Plant (1890) as a historical site could be flooded. When enlargement is completed, the social and cultural environment of the area would generally retrench to its present situations and trends.

The historic cultural sites to be affected by the enlargement of Chatfield Lake include the Highline Canal, the village of Waterton, Kassler Treatment Plant (1890), and the Hildebrand Ranch.

1. Highline Canal: The top of the planned conservation pool line is slightly below the canal alignment and it is probable that the canal would only occasionally be flooded. Recommended mitigation for this structure is to have it recorded by the Historic American Engineering Record.

2. Waterton: The village is at the very edge of the high water line of the present lake and would be within the proposed expansion high water line. The structures should be properly surveyed and evaluated if the lake is to be expanded.

3. Kassler Treatment Plant (1890): This facility could be within the potential reservoir and would have to be relocated on higher ground.

4. Hildebrand Ranch: The structures associated with this complex are among the oldest continuously occupied buildings in the state and they are on the National Register. As such, strong measures should be taken to protect them. They lie at the very edge of the maximum pool level and could be protected by a system of dikes. It is preferable to keep them in their present location.

Concept C

General

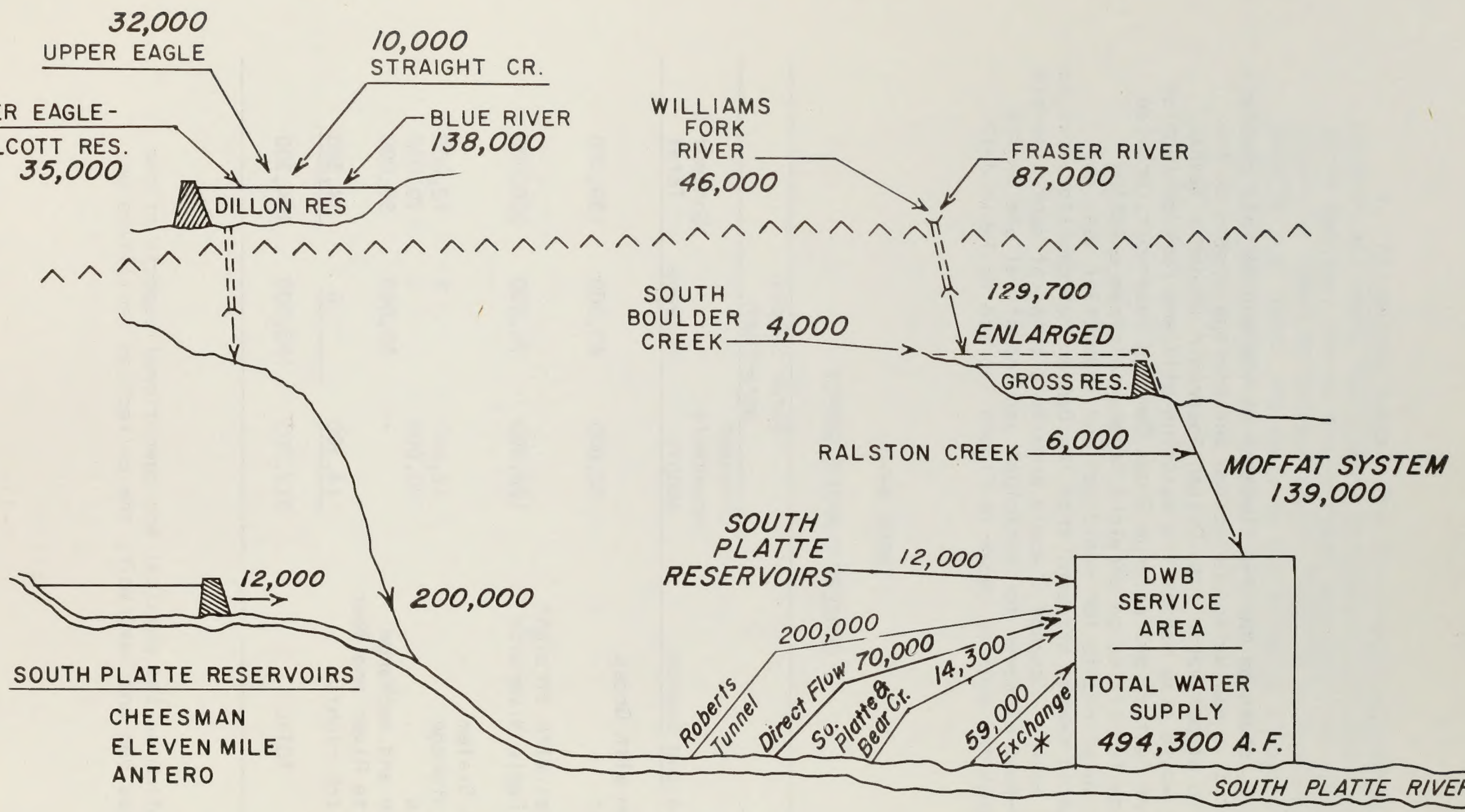
Concept C, shown on Map 8-3 (located at the end of this chapter), would consist of a new water collection and storage system on the Eagle River to divert water into Dillon Reservoir (Roberts Tunnel System). It would also expand the existing Williams Fork collection system (Moffat System) and enlarge Gross Dam and Reservoir, provide new collection facilities on Straight Creek, purchase existing agricultural water rights for municipal and industrial use, and exchange treated sewage effluent from the Denver metropolitan area for agricultural water. Concept C would provide a total of approximately 494,300 acre-feet of water for municipal and industrial use by the Denver metropolitan area as shown in Figure 8-6 and in Table 8-12.

TABLE 8-12

CONCEPT C WATER SUPPLY

	Water Supply acre-feet		
Feature and Source	Present dependable supply	Increase	Concept C Total
Moffat System with Gross enlargement	92,000	47,000	139,000
Roberts Tunnel with Straight Creek and Eagle diversion	124,000	76,000	200,000
South Platte System			
Reservoir storage	12,000	0	12,000
Direct flow	70,000	0	70,000
Acquisition and exchange	-	59,000	59,000
South Platte River and Bear Creek ditch rights	14,300	0	14,300
TOTAL	312.300	182,000	494,300

Information on the physical and operational aspects of the enlarged Gross Dam and Reservoir, the collection facilities on



* EXCHANGE includes acquired water rights

NOTE: ALL NUMBERS IN ACRE-FEET

WATER SUPPLY SCHEMATIC

CONCEPT C

FIGURE 8-6

Straight Creek, and the purchase and exchange of agricultural water rights given under the discussion on Concept A is also applicable to this concept; this information is not repeated here.

In Concept C, Dillon Dam and Lake would be used as the principal storage facility for regulating municipal and industrial water for treatment. No new regulatory storage would be provided in the South Platte River System.

The physical and operational description associated with expansion of the existing Williams Fork collection system and the new water collection and storage system on the Eagle River are discussed in the following pages.

Description

Features and Operation

Roberts Tunnel System (Eagle River Area). The plan would be to collect water from the Eagle River by pumping from the river near Wolcott into a reservoir and by gravity diversions from upper Eagle River tributaries above Minturn and Redcliff. These diverted flows would be conveyed in an easterly direction by both pressure, gravity tunnels, and conduits under the White River National Forest and the Gore Mountain Range into the north fork of Tenmile Creek, which flows into Dillon Reservoir. The water would be delivered from Dillon into the north fork of the South Platte River by the Roberts Tunnel. The principal features of this plan would be the Wolcott Dam and Reservoir, Eagle River Diversion Dam and Pumping Plant, Wolcott-Dillon Tunnel and Ute Creek Pumping Plant, and the Homestake-Dillon Tunnel.

Wolcott Dam and Reservoir would be located on Alkali Creek about 1 mile north of the town of Wolcott. A total storage capacity of 135,000 acre-feet would be required to regulate diverted river water at this site. The Eagle River Diversion Dam and Pumping Plant located on the Eagle River would divert water into Wolcott Reservoir through a 5,000-foot-long buried pressure conduit. From the reservoir, another buried conduit would convey water by gravity pressure to Ute Creek, where another pumping plant would discharge flow into the Wolcott-Dillon Tunnel. The Ute Creek Pumping Plant would have a total pump lift of about 2,000 feet. The Wolcott-Dillon Tunnel would be over 32 miles long and would range in diameter from 7 to 10 feet.

The other collection system, called the Homestake-Dillon Tunnel, would collect waters from Turkey Creek, Wearyman Creek, Resolution Creek, and other upper Eagle River tributaries and join the Wolcott-Dillon Tunnel at a point about 6.9 miles from the exit portal. The Homestake-Dillon Tunnel, with a total length of over 26 miles, would convey water entirely by gravity and would require a small

diversion structure on each tributary. A statistical summary is shown in Table 8-13.

At a point about 19 miles east of Wolcott Reservoir, the Wolcott-Dillon Tunnel would pass under the Eagle's Nest Wilderness boundary approximately 235 feet below the existing ground surface. From this point, about 12.9 miles of the tunnel would be constructed underground through the wilderness area boundaries. The tunnel would be constructed about 80 feet below the natural ground surface at the eastern wilderness boundary, which is approximately 1/2 mile west of the tunnel's east portal.

The Homestake-Dillon Tunnel would be about 75 feet underground entering the wilderness area. From this point, the remaining 1.7 miles of tunnel would be an average of 150 feet below the Eagle's Nest Wilderness surface area to where it connects into the Wolcott-Dillon Tunnel. About 7 percent of the tunnel's total length would be constructed under the wilderness area.

About 5.5 miles of new highway would be required to be constructed to replace a portion of the existing State Highway 131 that would be inundated by the potential Wolcott Reservoir.

Wolcott Dam could be constructed with selected earth material from borrow areas just north of the dam site and within the conservation pool. Excavation from the Wolcott-Dillon Tunnel, amounting to about 850,000 cubic yards, would be hauled out both the western and eastern portals as well as through three construction adits along the tunnel alignment. The eastern portal disposal area would be on DWB land adjacent to Dillon Lake. All other disposal areas would be outside the wilderness area. Excavation from the Homestake-Dillon Tunnel would be about 460,000 cubic yards. Disposal areas for this tunnel waste would be in the south portal area and through several construction adits, all of which would be outside the wilderness area boundary.

New 20-foot-wide gravel access roads required to build the above features would total about 12 miles. Access to the western end of the Wolcott-Dillon Tunnel would require about 4 miles of new road from relocated State Highway 131. In addition, about 6 miles of access road would be required to the Wolcott-Dillon Tunnel construction staging and adit areas from U. S. Highways 6 and 70. About 2 miles of improved and new access roads would be required to build the Homestake-Dillon Tunnel.

The average annual energy required for pumping at the Eagle River and Ute Creek plants would be about 117 million kwh. Electrical transmission facilities would consist of an additional 230/115 kV transformer and about 3 miles of new 115 kV transmission line from the existing Wolcott substation to the Eagle River and Ute Creek pumping

TABLE 8-13

ROBERTS TUNNEL SYSTEM

Potential feature	Quantity
Wolcott Dam and Reservoir	
Total conservation capacity (TCC)	125,000 ac-ft
Total storage capacity	135,000 ac-ft
Surface area at TCC	1,505 acres
W.S. elevation at TCC	7,330 feet
Minimum river release	natural inflow
Height of dam (above streambed)	276 ft
Crest length of dam	2,700 ft
Elevation, top of dam	7,338 ft
Eagle River Diversion Dam and Pumping Plant	
Height of dam	27 ft
Crest length	225 ft
Elevation, top of dam	6,920 ft
Pumping plant capacity	840 cfs
Length of discharge line	5,030 ft
Wolcott-Dillon Tunnel	
Capacity	72 cfs
Length	172,705 ft
Diameters	7 to 10 ft
Pumping plants	Ute Creek (1)
Homestake-Dillon Tunnel	
Capacity (minimum to maximum)	1-340 cfs
Length (26.4 miles)	139,250 ft
Diameters, varies from	2.5 to 8.83 ft

plants. This substation, located on the south side of Interstate Highway 70 near Wolcott, is owned by the Colorado Ute Electric Association. Power is transmitted to the existing substation by a 230-kV line from the coal-fired Colorado Ute power station near Hayden, Colorado.

Waters of the Eagle River watershed available to DWB would be diverted where possible by gravity and the remainder could be diverted near Wolcott by the pumping plant. The Eagle River pumping plant would operate during the months of May through July. These waters would be stored in Wolcott Reservoir and pumped during nine months of the year through the Wolcott-Dillon Tunnel. The pumping and gravity diversions from the Eagle River would be fully integrated with the operation of the Blue River collection system and the Roberts Tunnel diversion to optimize the water yield in the respective basins and to minimze pumping costs. The following tabulation shows the historic and future streamflows affected by the potential Eagle River collection system.

TABLE 8-14

STREAMFLOWS IN EAGLE RIVER COLLECTION SYSTEM

Stream	Quantity
Eagle River	
Miles affected (below Eagle River River Diversion Works)	23
Historic flows Average (1964-1973)	561 cfs
Future flows Average	465 cfs
Eagle River tributaries	
Miles affected	29.1
Accumulative historic flows Average	47 cfs
Accumulative future flows Average	3 cfs

The average water yield from the Upper Eagle gravity system would amount to about 32,000 acre-feet per year. The remaining tributary water which would flow into the Eagle River, to be diverted by the Wolcott Diversion Dam and pumping plant into Wolcott Reservoir, would provide an average annual water supply of approximately 35,000 acre-feet. Thus a net total of approximately 66,000 acre-feet of water would be obtained from this potential collection system, which does not include the 10,000 acre-foot yield from Straight Creek diversion.

The normal water surface drawdown in Wolcott Reservoir would be about 25 feet a year, dropping from a high elevation of 7,330 in midsummer to a low of 7,305 in late winter. The normal water surface area would vary from 1,505 to 1,350 acres on a seasonal basis. Although the reservoir would have about three years of holdover storage capacity (125,000 acre-feet), to protect against prolonged dry periods, extreme drawdowns could be expected.

Moffat System (William Fork River Area). The expanded Williams Fork collection system would consist of a dam and reservoir on the South Fork of the Williams Fork River (South Fork Dam) to collect upstream runoff from the basin, a gravity tunnel and a closed gravity conduit to convey the stored South Fork water to a pumping plant which would be located near the Williams Fork River, and a pressure conduit to transport South Fork water to a closed gravity conduit. This gravity conduit would convey the South Fork water to the existing collection system (Gumlick Tunnel) as well as collect runoff from eleven small tributaries of the north slope of the Williams Fork River Basin.

These tributaries are located between Darling Creek and McQueary Creek. The water obtained from the South Fork and the eleven tributaries would be added to that of the existing Williams Fork collection system. New appurtenant facilities would include access roads and powerlines.

The axis for the South Fork Dam site would be 1.6 miles upstream from the mouth of the South Fork of the Williams Fork River. The elevation of the streambed at the dam axis is approximately 9,045 feet. The total capacity of the reservoir would be 13,000 acre-feet. The area inundated by the reservoir would be 160 acres. The potential dam would be about 195 feet high with a crest length of 1,700 feet.

A diversion tunnel would bypass the stream during construction of the dam and later be incorporated as part of the reservoir's emergency spillway. Embankment material for the dam could be obtained from borrow areas located downstream.

The tunnel and closed conduit from the reservoir to the pumping plant would operate by gravity and would be approximately 1.5 miles long.

The pumping plant site is in a flat area on the north bank of the Williams Fork River 0.2 mile downstream from its confluence with the Middle Fork, approximately 400 feet from the river. The elevation at the site is approximately 9,050 feet.

The pressure discharge line from the pumping plant to the gravity conduit would be made of steel pipe 0.8 mile long. Most of the pipe would be buried, although some of the pipe would be elevated on concrete piers. An energy dissipating structure would be required where the discharge line joins the gravity conduit. The proposed location for this structure is alongside the existing North Fork road.

The north slope gravity conduit would extend from a tributary of Darling Creek to McQueary Creek, a distance of about 10 miles. The conduit would carry water under open-channel flow conditions. The existing conduit from the Gumlick Tunnel inlet to McQueary Creek, a distance of 1.5 miles, would be removed and replaced with a larger diameter pipe. The north slope gravity system would also require new diversion structures for those streamflows being collected between McQueary Creek and Darling Creek tributaries. Backfill material for construction of the conduit could be obtained from borrow sites along the existing North Fork road. Improvements in the existing North Fork road would also be necessary.

New access roads required would include approximately 1 mile reach of gravel road 20 feet wide from the existing Sugarloaf Campground road to the pumping plant and approximately 4.5 miles of gravel road 16 feet wide switching back and forth across the pressure discharge line from the pumping plant to the gravity conduit.

Electrical power transmission facilities would include a new single-pole line 1.8 miles long from the existing substation near the west portal of the Henderson Tunnel to the pumping plant and a single-pole line 2 miles long from the same substation to the South Fork Dam. For the most part, the powerlines would be constructed next to access roads in the area.

The operation of the expanded William Fork collection system would be consistent with Colorado water law and other legal agreements, the need for additional water in Denver, and the capacity of the DWB's system to transport and store the water.

Runoff forecasting and other water resource management techniques would be used to determine the need for additional Williams Fork water. If it is determined that runoff from other sources is adequate, little or no water would be pumped from the South Fork

Reservoir. The amount and timing of water pumped from the South Fork Reservoir would also be dependent on the demand for raw water.

The dam and reservoir on the South Fork of the Williams Fork River, the collection of water from the eleven tributaries of the north slope of the Williams Fork River Basin, and the enlarged Gross Reservoir would develop a total of 46,000 acre-feet of water. The new storage and collection facilities would account for 28,400 acre-feet of this total.

Present Environment

Soils and Terrestrial Resources. The following description covers only the Eagle River area. The description of the existing environment in the Williams Fork River watershed provided under Concept A is also applicable to Concept C.

Soils of the mountain slopes in the Eagle River area are of varying depths and are derived primarily from gneiss, granite, and schist. Soil pH ranges from acidic in the more mountainous terrain to alkaline in the lower elevations of the Eagle River drainage basin. Where vegetation offers protection, natural erosion is limited.

Concept A includes a detailed description, based upon range site descriptions of the Soil Conservation Service, of the soil types that might be found at varying elevations within the area.

The primary vegetative types within the study are the (1) spruce-fir forests, (2) lodgepole pine stands, (3) aspen groves, (4) high mountain forest riparian, (5) upper montane-subalpine dry meadows, (6) upper montane-subalpine wet meadows, (7) pinon-juniper complex, and (8) sagebrush flats. These biotic communities are distributed throughout the area in a complex mosaic. The boundaries between these ecosystems are not sharply defined since they tend to blend with one another in zones of transition called ecotones.

The predominant plant species and associated terrestrial wildlife community characteristic of the first six vegetative types have been described for the Roberts Tunnel System as part of Concept A.

The dominant floral elements of the pinon-juniper complex are Utah juniper, pinon pine, and several species of rabbitbrush. This lower elevation (6,000 to 8,000 feet) vegetative type is winter forage for large numbers of deer and elk. The shrub understory is available to wildlife except under the most severe winter conditions.

Other common shrubs and ground cover within the pinon-juniper "pygmy forest" are scrub oaks, mountain mahogany, serviceberry, groundsel, fleabane, golden beard, yucca, and cholla cactus.

Among the small rodents occupying pinon-juniper habitat are ground squirrels, deer mice, and cliff chipmunks. Large mammals which typically inhabit the area include mule deer, mountain lions, and coyotes.

Birds considered to be characteristic of the pinon-juniper woodland include the pinon jay, common bushtit, blue-gray gnatcatcher, brown towhee, plains titmouse, and scaled quail.

The sagebrush vegetative type occurs on dry open valleys at lower elevations throughout the study area.

The sagebrush vegetation type occurs in dense stands along open valley flats at lower elevations in the study area. The dominant plant species, big sagebrush and rabbitbrush, are mixed with a variety of shrubs (e.g., bitterbrush, currants, mountain mahogany, juniper, serviceberry, winterfat, snowberry) and grasses (bluegrass, squirreltail, western and bluebunch wheatgrass, Idaho fescue, needlegrass). Broomweed is a common invader species of disturbed areas. This ecosystem provides excellent winter forage for mule deer, elk, and domestic livestock.

Other mammals characteristic of the sagebrush ecosystem that are commonly found in the study area are the white-tailed jackrabbit, Richardson's ground squirrel, coyote, and a wide variety of mice and voles. Birds typically using sagebrush flats for nesting or feeding include the sage grouse, mourning dove, Brewer's sparrow, lark sparrow, green-tailed towhee, pinon jay, rock wren, common bushtit, western kingbird, gray flycatcher, Say's phoebe, nighthawk, red-tailed hawk, golden eagle, marsh hawk, sparrow hawk, turkey vulture and great-horned owl.

Southern slopes at higher elevation (8,000 to 11,500 feet) in the area support dense spruce-fir forests. High stream valleys are predominantly open and vegetated with dry meadows and riparian stands of willow and bog birch. South-facing slopes support scattered stands of aspen and lodgepole pine.

Wider stream valleys of lower elevations (6,000 to 7,500 feet) terminate against gently rolling foothills dominated by sagebrush flats and pinon-juniper forests. The valley floors support a mixture of sagebrush, juniper, and a few pinon pines with sparse ground cover. The riparian ecosystem in these locations consists of dense willow thickets; riparian ecosystem in these locations consists of dense willow thickets, an occasional cottonwood and blue spruce, and a mixed understory of forbs, sedges, and rushes. Often stream confluences are dominated by a wet meadow of grasses, cattails, and sedges.

Mule deer and elk utilize the spruce-fir forests and aspen stands extensively for cover. During the summer, big game utilize the meadow

and riparian communities of the higher elevation (8,000 to 11,000 feet) as a source of food and water.

Aquatic Resources. The Eagle River and its tributaries support cold water fisheries, which include trout populations of variable size. Brown trout dominate in the main stem and most tributaries, with brook trout also providing a fishable population in most streams (Woodward-Envicon 1973). Rainbow and cutthroat trout also occur in several streams but are not abundant. The puite sculpin (formerly the eagel sculpin) is also present in most streams (Woodward-Envicon 1973).

The benthic invertebrates in the Eagle River and most tributaries are dominated by mayflies, with stoneflies second in relative abundance (Woodward-Envicon 1973). Immediately downstream from the Pando Dam, caddisflies are co-dominant with the mayflies.

The aquatic life of the Fraser and Williams Fork Rivers and Dillon Reservoir were previously discussed under Concept A. The aquatic systems of the east slope streams and reservoirs were also described under Concept A.

Under Concept C, additional water would be diverted from the Eagle River. The water quality of the Eagle River at the Wolcott Dam site, with the exception of Alkali Creek, is excellent. Alkali Creek, as befits its name, carries a somewhat greater salt load. The high salinity reflects the high concentration of sulfates in the drainage. At times, sulfates in Alkali Creek exceed the water quality standard for drinking water of 250 mg/l. Samples have been collected since 1972 by the DWB (DWB, undated). These show sulfate concentrations up to 400 mg/l. However, once this is mixed with the higher quality water from the Eagle River, dilution usually brings the sulfate concentration to within acceptable levels. Over the same period of record as Alkali Creek, the Eagle River immediately downstream from their confluence exceeded the 250 mg/l standard on one occasion with a concentration of 275 mg/l. No other water quality standards or criteria for raw water have been exceeded at other points in the Eagle River collection system.

The water quality of the Fraser, Williams Fork, and South Platte Rivers and Gross and Dillon Reservoirs was described under the discussion of Concept A.

Important and Endangered Species. Mule deer and elk are the most common big-game species in the Eagle-Piney study area while black bear, mountain lion, and bighorn sheep are also present. Eagle County is ranked among the top 10 counties in the state for both deer and elk harvest (DOW 1974).

The pinon-juniper and sagebrush ecosystems in the study area are particularly important as mule deer winter range (Woodward-Envicon 1973). High deer pellet group counts in the vicinity of the potential Wolcott Dam and Reservoir have been recorded (Woodward-Envicon 1973). In addition, the Area Supervisor for the Colorado Division of Wildlife reported that a major east-west deer migration route existed at the Wolcott Reservoir site (Woodward-Envicon 1973). This portion of the study area is also a part of extensive elk winter range. The heavily browsed condition of the vegetation in the Wolcott Reservoir vicinity indicated that this range was fully stocked with elk (Woodward-Envicon 1973).

The most abundant small-game mammal in the study area is the snowshoe hare. The Alkali Creek valley in the study area supports a locally important sport hunting population of Nuttall's cottontails (Woodward-Envicon 1973).

The most common game bird in the study area, the blue grouse, accounted for more than 25 percent of the state's total harvest of this species in 1974 (DOW 1974). The sage grouse is also common, and there are small populations of ptarmigan, mourning dove, and wild turkey.

According to a local ornithologist, the site of the potential Wolcott Reservoir lies along a heavily used bird migration route (Woodward-Envicon 1973). The most commonly observed species in this area are blue-winged teal and mallards. Additional sightings include the white-faced ibis, osprey, great blue heron, and bald eagle.

There are no known federally endangered mammals within the Eagle River area (DOW 1976). However, the historic ranges of three mammals, classified as endangered by the State of Colorado, overlap the Eagle watershed. They are the wolverine, Canadian lynx, and river otter. Portions of Eagle County are listed as areas of special interest for the wolverine (DOW 1976). Eagle County also contains habitat considered by the state to be essential to the Canadian lynx (DOW 1976). In addition, the state has plans to introduce river otters into the Eagle River drainage basin (personal communication, DOW 1977).

The endangered peregrine falcon has been known to breed within the Eagle drainage basin. The state has identified portions of Eagle County along the Eagle River as essential habitat for the peregrine falcon (DOW 1976). Both the federally protected bald and golden eagles have been observed in the Eagle River watershed. A prior study indicated that both species may also breed within the Eagle study area (Woodward-Envicon, Inc. 1973). No other endangered bird species are known to exist in the study area.

Reference is made to Concept A for a discussion of the status of endangered plants, amphibians, and reptiles in Colorado.

Recreation, Socio-Economic Conditions, and Cultural Resources. The recreational, socio-economic, and cultural structure of the Williams Fork and Fraser River area (Moffat System) and the Dillon area (Roberts Tunnel System) is described in detail under Concept A. The additional coverage for Concept C will therefore concentrate on the Eagle River collection area.

Recreation and tourism are considered major industries within Eagle and Summit Counties. Major recreation resources include Dillon and Williams Fork Reservoirs, White River and Arapahoe National Forests, and the Gore Range-Eagles Nest Wilderness Area. There are six major ski areas within the Concept C area.

The area has recreation resources and facility needs for hiking, horseback riding, four-wheel vehicle driving, mountain climbing, picnicking, camping, boating (canoe and raft in streams and lakes), stream and lake fishing, hunting, cross-country skiing, and open snowmobiling. The streams are generally good for cold water fishing. The reservoirs are also good for fishing except for Williams Fork Reservoir, which is rated poor in the summer and fair in the fall. Hunting is described as good for big game.

The social and economic structure of the area in which the potential Eagle River water collection system would be located is based around mining, agriculture, construction, and recreation, but primarily the latter.

Located in Eagle County, the terrain is mountainous and conducive to winter sports and equally pleasurable summer activities. Responding to the demand of both tourists and Coloradans, the town of Vail has mushroomed into a vital and progressive center of summer and winter recreational activity, impacting the economy, society, and population of the county. In 1970 there were about 7,100 people residing in Eagle County; the population is now estimated at about 12,000.

Mining, the second largest industry in the county, is giving way to tourism, which dominates the local economy. The Gilman Mine is the largest source of mining production and has assisted the economy of Minturn, Gilman, and Redcliff.

There is some agriculture to the west of Vail and in the area of Wolcott and Edwards, and cattle graze in the meadows paralleling the Eagle River, but the stimulus of economic activity is at Vail. Here all ages congregate on the slopes of the surrounding mountains in the winter to ski. Hiking, fishing, photography, golfing, and other outdoor opportunities add to skiing, and those recreational activities

make this county, with its proximity to a major east-west highway, and particularly the section influenced by the potential collection system, a delightful place to live.

Although the population of Vail is, to a great extent, transient, with many visitors using their condominiums on weekends, there are permanent residents to assure a stable community, which will continue to expand as long as the geographical confines of the mountains permit.

The results of the previous cultural resource investigations in the area of the Williams Fork System (CH_2M Hill 1976) were described under Concept A; those results apply to this concept also. The only difference is the magnitude of the areas which could be involved under the two plans. Under Concept A, the Williams Fork System would alter streamflows. Under Concept C, there would be a number of structural additions. Concept C would require more survey work for archaeological sites prior to construction than Concept A and may ultimately require more mitigation.

The Eagle River System has had little survey work done for archaeological and historical cultural resources. The only mention of such resources is in Woodward-Envicon 1972. In their inventory of natural, scenic, and historic areas, they mention twelve historic sites of varying degrees of interest, and indicate that no archaeological sites have been encountered. However, there is ethnographic evidence that Utes used the area for hunting in historic times (Henderson 1926).

By inference and limited evidence, the types of cultural resources available in the above two components of Concept C would be very similar to those encountered in the upper areas of the potential Two Forks Reservoir. There are no sites in either of the Concept C areas that are on the National Register of Historic Places. As with the other concepts, it is very difficult to estimate quantity and/or quality of resources for the components of Concept C without more intensive survey work in each area. In either case, further survey work is necessary to establish a better base for information on cultural resources for this concept.

Analysis

Environmental Impacts

The impacts covered here (Concept C) are those involving potential construction and operation of the water collection system on the Eagle River and expansion of the Williams Fork collection system.

General. The following discussion relates to temporary construction impacts only. Long-term impacts follow under appropriate headings.

Construction and enlargement of the above water collection systems would result in temporary, localized deterioration of air, noise, and water quality. Increases in noise and dust levels would be disturbing to recreationists and permanent residents. Increases in dust, hydrocarbons, nitrogen oxide, and carbon monoxide would result from the operation of heavy construction machinery.

Temporary unavoidable soil erosion from borrow areas and contractor haul spills could increase stream turbidity, which would reduce the quality of fishing as well as other water sport activities.

Following construction, borrow and waste disposal areas would be backfilled, shaped, and reseeded to blend with the natural surroundings.

The construction of the 37-mile tunnel (Wolcott-Dillon) passing under the Eagles Nest Wilderness Area would have no anticipated impact on the wilderness quality or experience of area visitors. All construction staging and access would be outside the wilderness area boundary, as would the disposal of excavated materials. Since the tunnel through the wilderness area would be from about 80 to 235 feet below the natural ground surface, no anticipated impact to wildlife from blasting should occur. Construction of a new access road for tunnel construction would cause temporary disruption to recreationists and displacement of wildlife.

Construction activity at South Fork and Wolcott Dams would also interfere with the quality of recreation experience. These activities would cut off accessibility to remote areas, forcing recreation users to drive around the construction site and to compete with construction vehicles for the use of narrow mountain roads and limited parking. New trails would need to be established for hikers, backpackers, and hunters.

The construction of the South Fork Dam would occur in a remote area and would be incongruent with the wilderness character of that area. Noise and dust associated with construction in this area would also degrade the quality of the recreation experience.

The impacts on the socio-economic structure of the communities involved in and near the construction sites would be similar to those of Concepts A and B. Businesses would be temporarily improved through the insurgence of the working forces, but the limited civic facilities of smaller communities could be taxed. This situation would be temporary, and the impact would terminate with the completion of construction.

Terrestrial Resources. The Eagle River diversion dam and pumping plant would be located near the confluence of Alkali Creek and the Eagle River, at an elevation of approximately 6,920 feet. The riparian habitat along Alkali Creek and the Eagle River in this area is of excellent quality, including many large Colorado blue spruce (Woodward-Envicon 1973).

Approximately 40 acres would be required for construction of the diversion dam and pumping plant. Construction activities would disrupt terrestrial vegetation and displace wildlife. Primary wildlife species affected would include those which make extensive use of riparian vegetation.

Due to the high quality of existing habitat and limited adjacent similar habitat, some displaced wildlife could have difficulty relocating and perish. Following construction, the value of the disturbed habitat could be restored through re-contouring and seeding with native vegetation. However, complete natural restoration of the riparian habitat would require hundreds of years.

Wolcott Dam and Reservoir would be constructed on Alkali Creek about 1 mile upstream from its confluence with the Eagle River. Surface area at the top of the conservation pool (elevation 7,300 feet) would be 1,505 acres. An additional 1,055 acres of right-of-way would be required for dam and reservoir construction.

The primary vegetative type inundated would be the sagebrush flats, including scattered junipers and pinon pines, of the wide valley floor. Also, some upland areas supporting both sagebrush flats and pinon-juniper forests would be flooded. The riparian habitat along Alkali Creek that would be lost consists primarily of dense willow thickets with a mixed forb understory.

At least 1,500 acres of terrestrial vegetation would be permanently lost by reservoir operation. Terrestrial wildlife would be displaced both by this loss of habitat and construction activities. The project site is part of a major winter range for deer and elk and also provides habitat which is important to the Nuttall's cottontail (Woodward-Envicon 1973).

The potential reservoir would inundate and require relocation of 5.5 miles of State Highway 131. Construction along a 150-foot (average) right-of-way would temporarily disturb sagebrush and pinon-juniper vegetative types and displace wildlife. Terrestrial vegetation within a 50-foot operation right-of-way would be permanently lost.

Removal of borrow materials for the potential dam would be from within the conservation pool and would have no additional impact on vegetation and associated wildlife. Recontouring and seeding of

construction areas could minimize the project's impact on terrestrial ecosystems.

The Wolcott-Dillon Tunnel would extend more than 32 miles in an easterly direction, transporting water from the Eagle River pumping plant, under the White River National Forest and Gore Mountain Range, and into the Tenmile Creek drainage just west of the town of Frisco.

Impacts to terrestrial ecosystems woud occur at the west and east portals of the potential tunnel. Lodgepole pine stands dominate south-facing slopes, and spruce-fir forests cover north-facing slopes in the west portal area. Construction and waste disposal in the west portal area would involve approximately 40 acres.

Some wildlife would be displaced by construction activities and destruction of habitat. Big game only occasionally migrate through this area, while the porcupine, golden-mantled ground squirrel, and chickaree are the most common inhabitants (Woodward-Envicon 1973). If the portal is constructed within the lodgepole pine forests of the northern slopes, the impact to terrestrial wildlife could be minimized.

Vegetation within the potential east portal construction area consists mainly of aspen groves mixed with stands of lodgepole. Abundance of riparian vegetation and the associated terrestrial wildlife community has been reduced by construction of Interstate Highway 70 and development around the town of Frisco. The amount of big-game activity in the area is limited (Woodward-Envicon 1973). Wildlife displaced by construction activity and habitat destruction should be able to successfully relocate.

Impacts to terrestrial ecosystems could be reduced by construction of the east portal and associate energy dissipators as close to Interstate Highway 70 as possible. The Wolcott-Dillon Tunnel construction and discharges should not impact the Colorado Division of Highway-Division of Wildlife stream habitat improvement project along Tenmile Creek upstream from the potential construction site.

A portion of the Wolcott-Dillon Tunnel would be constructed underground within the boundaries of the Eagles Nest Wilderness Area. Nineteen miles from the potential Wolcott Reservoir, the tunnel would pass about 235 feet below the wilderness area boundary, extend for about 80 feet below the east boundary, one-half mile from the east portal site. This construction would have limited impact on the terrestrial ecosystems of the Eagles Nest Wilderness Area.

All of the 850,000 cubic yards of material excavated from the Wolcott-Dillon Tunnel would be disposed of outside of the Eagles Nest Wilderness Area boundaries. The eastern portal disposal area would be on DWB land adjacent to Dillon Lake. Impacts of tunnel construction

on terrestrial ecosystems could be reduced by recontouring and seeding disturbed areas immediately after the completion of construction.

Construction and waste disposal impacts would also occur in the immediate area of the two tunnel adits (vertical shafts used for access during construction and in maintenance) required for the Wolcott-Dillon Tunnel. Impacts to terrestrial ecosystems would be similar to those in the west portal area. The impact area would involve about 80 acres.

The Ute Creek pumping plant would be constructed within a sagebrush flat near the east bank of Ute Creek. Total land required for plant construction would be 40 acres. Terrestrial vegetation would be temporarily distrubed by construction and destroyed by placement of permanent facilities.

Due to the abundance of similar habitat in the vicinity of the potential construction site, most displaced wildlife should be able to successfully relocate.

The Homestake-Dillon Tunnel would extend a length of more than 26 miles from the upper end of the Eagle River watershed to an intersection with the Wolcott-Dillon Tunnel, about 150 feet below the surface of the Eagles Nest Wilderness Area, and 6.9 miles from the Wolcott-Dillon east portal.

Portal construction of the Homestake-Dillon Tunnel would disturb vegetation and displace terrestrial wildlife. The 460,000 cubic yards of material excavated during tunnel construction would impact about 80 acres entirely outside the boundaries of the Eagles Nest Wilderness Area. This impact area should be contoured and seeded with native vegetation.

As a result of the potential project, average annual streamflows in a 23-mile reach of the Eagle River would be reduced from 561 cfs to 465 cfs. Such a flow reduction should have no effects on the existing quality of riparian vegetation. However, annual flows of a collective 29 miles of Eagle River tributaries would be reduced by about 90 percent (i.e., 47 cfs to 3 cfs). Tennant (1975) has noted that flow reductions of this magnitude can result in reduction of abundance and diversity of plant species comprising the riparian habitat. Diminishing the quality of streamside vegetation would result in the displacement and possible loss of terrestrial wildlife.

The collection system for the Homestake-Dillon Tunnel would reduce the flow and degrade the riparian habitat along 1.2 miles of the East Fork of the Eagle River, 0.5 mile of the South Fork of the Eagle River, 0.9 mile of Wearyman Creek, 3.4 miles of Turkey Creek, 0.7 mile of Lime Creek, 3.1 miles of Black Gore Creek, and 1.7 miles of seven unnamed tributaries to Homestake Creek, 10.2 miles of

Homestake Creek, 0.4 mile of Piney Creek, 0.3 mile of Yoder Creek, and 0.6 mile of Resolution Creek.

Of these, the greatest impacts to riparian vegetation and associated wildlife communities would occur along Wearyman, Lime, and Turkey Creeks. The habitat along all three streams is similar: mainly spruce-fir forests, but liberally mixed with aspen groves, lodgepole pine stands, and sagebrush and willow thickets. These three drainage areas have been described as excellent habitat for elk, blue grouse, and small raptors (i.e., Cooper's hawk, goshawk, sharp-shinned hawk) (Woodward-Envicon 1973). Due to the high quality of this streamside habitat and lack of adjacent similar habitat, streamflow depletions should result in the loss of terrestrial wildlife.

The collection system for the Wolcott-Dillon Tunnel would deplete flows in 3.8 miles of Red Sandstone Creek, and 2.9 miles of Middle Creek. Both of these streams support good quality riparian vegetation. Flow reductions of more than 90 percent would diminish the quality of this habitat and displace terrestrial wildlife.

Project development within the Eagle study area would also require the construction of 12 miles of new 20-foot-wide gravel roads, and 3 miles of new 115 kV transmission lines. Vegetation within a 100-foot-wide (average) construction right-of-way would be temporarily disturbed and wildlife would be displaced. As the exact nature and location of access road and transmission line construction has not been determined, specific impacts to terrestrial ecosystems cannot be discussed. However, impacts could be minimized by recontouring and seeding construction areas to native vegetation.

The potential South Fork Reservoir would inundate 1 mile of high mountain (9,200 feet) forest riparian habitat along the South Fork of the Williams Fork River. Dam and reservoir construction would require a 300-acre right-of-way with 160 acres being flooded when the water level is at the top of the conservation pool. The primary upland vegetative type within the potential reservoir boundary should be spruce-fir forest.

Construction activity and inundation would displace terrestrial wildlife from portions of the steep walls of the north-south trending canyon and riparian habitat along the valley floor.

If partially occupied similar habitat is available within a reasonable migratory distance, most displaced animals could successfully relocate. The abundance of forest land and associated riparian habitat within the project area vicinity should facilitate wildlife relocation. Impacts to terrestrial ecosystems could be reduced by minimizing the destruction of existing vegetation during construction and recontouring and seeding disturbed land following construction. The spruce-fir climax forest is a floristically uniform

and ecologically simple community; however, simplicity and uniformity in community structure do not imply simplicity of origin or that reestablishment would be fast or complete. It has been estimated (Ives 1941) that a period of 300 years would be required to reestablish a spruce-fir climax community. The oldest canopy members of a spruce-fir forest may be in excess of 500 years (Oosting and Reed 1952).

Additional wildlife habitat would be temporarily disturbed by the removal of borrow materials downstream from the dam site. During construction of the dam, the streamflow would be bypassed through a diversion tunnel. This should minimize the degradation of downstream riparian habitat that could be associated with streamflow depletion during construction.

A closed gravity conduit would extend for 1.3 miles through spruce-fir forests as it crosses the west- and east-facing slopes and peak of Sugarloaf Mountain (10,000 feet), between the potential South Fork Reservoir and Williams Fork River pumping plant. The buried conduit would also cross the main Williams Fork River in an area bounded by forest riparian habitat. This potential action would disturb vegetation and displace associated wildlife. Displaced animals should be able to successfully relocate due to abundant similar habitat in adjacent uplands and stream valleys. Destruction of the spruce-fir climax along the 50-foot-wide construction right-of-way would have to be considered to be a long-term impact due to the time required (i.e., 300 years) for reestablishment of vegetation.

The Williams Fork River pumping plant would be constructed in relatively flat valley uplands (9,050 feet) abutted to the north by steep, south-facing slopes. Dominant vegetation should be a mixture of forest riparian and forest upland habitat, probably including a mixture of willows, bog birch, aspen, spruce-fir, and lodgepole pine.

Plant construction would disturb 5 acres of terrestrial vegetation and displace associated wildlife. Following construction, 4 acres of land could be partially reclaimed by recontouring and seeding with native vegetation.

The conduit between the Williams Fork pumping plant and the Gumlick Tunnel would traverse 10.6 miles of primarily forest land with a few scattered patches of subalpine dry meadow. The first portion of this conduit (0.8 mile) would be pressurized, consisting of a combination of buried and elevated (on concrete piers) pipeline. The remainder (9.8 miles) would be open-channel, gravity conduit. According to the topographic map of the area (USGS, Ute Creek 15-foot Quadrangle, 1933), approximately 95 percent of the conduit corridor would be through subalpine (9,250 to 10,400 feet) forest. Seventy percent of the route would be along south-facing slopes with the

remainder traversing a northeast trending ridge. Accordingly, the vegetation along the route should be predominantly spruce-fir forests liberally mixed with aspen groves and lodgepole pine stands.

The 50-foot-wide construction right-of-way would also cross eleven small tributaries of the Williams Fork River between Darling and McQueary Creeks. None of these streams are bordered by high mountain forest riparian habitat. One flows through primarily open wet meadows and one (McQueary Creek) is adjacent to a mixture of these two vegetative types.

Construction of the conduit would disturb vegetation and displace associated wildlife. Due to the length of the potential conduit (i.e., 10.6 miles) and probable degree of vegetation clearing required, some of the displaced animals, failing at relocation attempts, could perish. Recontouring and seeding could reduce the impacts to terrestrial ecosystems. In addition, the elevated portions of the 0.8 mile pressurized conduit could impact wildlife migration routes.

Borrow sites for conduit construction would be along the existing North Fork road; thus, the impact to terrestrial vegetation and wildlife should be minimized.

The existing 1.5-mile-long tunnel between McQueary Creek and the Gumlick Tunnel would be removed and replaced with larger diameter pipe. This should primarily impact the spruce-fir ecosystem along the 50-foot-wide construction right-of-way on the steep west-facing slope at an elevation of 10,400 feet. Some displaced wildlife could have difficulty relocating and perish.

Project development would entail construction of new access roads and power transmission lines as well as improvement of the existing North Fork road which parallels the potential conduit corridor. A 1.8-mile single-pole transmission line would be constructed between the existing Henderson substation and the Williams Fork pumping plant site. This activity would disturb 11 acres of high mountain forest and willow-birch riparian ecosystems. In addition, the proposed route would cross the upper reach of the main Williams Fork River. Construction activity would displace wildlife and could result in the loss of some animals. Another single-pole transmission line, requiring 12 acres of construction right-of-way, would traverse the 2-mile distance between the Henderson substation and the South Fork dam site. This route would cross the South Fork of the Williams Fork River, disturbing primarily the high mountain forest flood plain and riparian vegetative communities. Again, wildlife would be displaced and could perish if unable to relocate in adjacent habitat. Portions of both of these transmission lines would parallel existing access road corridors, thus reducing the impact on terrestrial ecosystems.

One mile of new 20-foot-wide gravel access road would be constructed between the existing Sugarloaf Campground and the Williams Fork pumping plant. This route would loop the transmission line corridor, thus minimizing impacts to terrestrial ecosystems.

Another 4.6 miles of new access road would be constructed between the Williams Fork pumping plant and the potential open-channel gravity conduit. While this route would ascend the area planned for construction of the 0.8 mile of closed pressure conduit, impact to the predominant spruce-fir, aspen, and lodgepole pine forestland would be magnified. Due to the steep, south-facing slope, the 16-foot-wide gravel road would have to be constructed using severe switchbacks across the conduit corridor. This would result in the disruption of an additional 27 acres of terrestrial vegetation and commensurate displacement of wildlife.

Approximately 10 miles of the existing North Fork access road would have to be improved in order to construct and service the open-channel gravity conduit. This activity would take place entirely within the potential conduit construction corridor and thus not have any impacts on terrestrial ecosystems beyond those previously discussed for the conduit.

Small diversion structures would be constructed on eleven tributaries of the Williams Fork River at elevations of 10,400 to 10,600 feet. Collectively, the average annual flow in these streams would be reduced by more than 90 percent. According to Tennant (1975) such flow reductions would degrade the quality of riparian habitat along these streams downstream from the diversion points to the confluence with the Williams Fork River. Streamside vegetation in this area should be primarily mixed stands of Englemann spruce, subalpine fir, aspen, and lodgepole pine, with thickets of willow and bog birch directly adjacent to and within the stream channel. Reduction of the quantity of riparian habitat along 6 miles of babbling mountain brooks would also displace wildlife. Due to the relatively large drainage area affected by these streamflow depletions, some displaced animals, having difficulty relocating, could perish.

Aquatic Resources. Annual depletion of the Eagle River and its tributaries would be quite variable, ranging from about 20 percent on the Eagle River to about 90 percent on the tributary streams. Depletions in the area of 20 percent during the peak runoff period would not lead to any significant impacts on either the fishery or supporting populations of aquatic organisms. However, depletions of 90 percent would significantly reduce the available aquatic habitat and the standing crop of aquatic organisms and total stream productivity. However, depletions of 90 percent would significantly reduce the available aquatic habitat and the standing crop of aquatic organisms and total stream productivity. However, the smaller streams

have been relatively unproductive under current conditions due to steep gradients and small size (Woodward-Envicon 1973). Sampling indicated that no fish or extremely low populations were present in several streams (Woodward-Envicon 1973).

The dams, for both diversion and storage, would affect the existing aquatic communities. Dams in general block the upstream migration of fish. This can result in an effective loss of spawning habitat, although this would not be significant if there is sufficient habitat downstream from the dam. However, several of the streams that support populations of brook and/or cutthroat trout are so small and shallow that they may freeze to the bottom under the right circumstances, eliminating the fish. The diversion dams in such a case would block repopulation from larger downstream areas.

The storage reservoir on the South Fork of the Williams Fork would bring about a change in the aquatic community. For example, stoneflies supply the second highest biomass of invertebrates currently. Impoundment would essentially eliminate the stoneflies from the river reach since they are adapted to a running water habitat. The sculpin would be similarly eliminated. There would be an increase in caddisflies and trueflies, as well as aquatic earthworms, which are more adapted to slow-moving or standing waters. The river reach where the reservoir would be impounded supports a good standing crop of brook trout and provides heavily used spawning habitat (CH_2M Hill 1976); the latter would be eliminated. Impoundment would also decrease the maximum summer temperatures and provide colder water to the downstream river reach; this could further alter the stream ecology below the dam. On the other hand, sampling on Alkali Creek indicated no fish. Impoundment and additional diversion from the Eagle River would provide a fishery where little or none presently exists (Woodward-Envicon 1973).

Concept C provides for no east slope storage other than the enlargement of Gross Reservoir. The enlargement of Gross Reservoir was discussed under Concepts A and B. Other impacts would be similar in magnitude to those of the Foothills Project at the 125 mgd level, except that the remaining reach of the North Fork would have to be stabilized. This would result in extensive degradation of the remaining habitat.

The water quality standard of 250 mg/l of sulfate for waters for domestic use has been exceeded on occasion in the lower Eagle River. However, other waters diverted through Roberts Tunnel are relatively low in sulfates and would be available for dilution. As a result, no additional treatment costs would be incurred for the removal of excessive soluble salts such as sulfates. All other concentrations of chemical constituents are within acceptable limits, and standard treatment only would be required prior to distribution.

Under Concept C, an annual average of 266,000 acre-feet of relatively high-quality water would be diverted from the upper Colorado River drainage to the Denver metropolitan area for municipal and industrial use. This diverted water would be considerably lower in salinity than that downstream and would be unavailable for dilution. An annual average of 41,000 tons of dissolved solids would also be diverted to the east slope. However, as was the case in Concepts A and B, an increase in downstream salinity concentrations in the Colorado River could be expected. As outlined, development of Concept C, using the same criteria as for Concept A, would result in an approximate increase in salinity concentrations in the Colorado River at Cameo, Colorado, of 38 mg/l. and 23 mg/l at Imperial Dam, Arizona.

An increase in municipal and industrial water would increase the volume of effluent from the Denver metropolitan sewage systems. Through the proposed effluent exchange program, there would be less diluting water and a great quantity of sewage effluent in the South Platte River. Under this concept, the exchange program would provide an additional 72.000 acre-feet per year of raw water in exchange for a like amount of effluent to be diverted downstream. This would result in higher levels of biological oxygen demand, dissolved solids, and any industrial chemicals not removed in the treatment process at least as far downstream as the final diversion point. However, there would be less degradation than would occur under the previous two concepts because of the greater amount of diluting water available.

Disposal of material excavated from the Wolcott-Dillon Tunnel on DWB land around the edge of Dillon Reservoir could impact waterfowl nesting and feeding habitat as well as brown and rainbow trout spawning and migration habitat. The disposal plan in this area would require close controls to assure placement of waste material above the maximum water surface elevation of Dillon Reservoir and above the bottom flood plain land of Tenmile Creek.

Important and Endangered Species. Because the Eagle River watershed supports some of the best elk and mule deer habitat in Colorado, the potential development would impact both of these species. During construction, total harvest of these big-game species as well as other small game (e.g., snowshoe hare, blue grouse) species within the study area should decrease. In addition, the populations of beaver, muskrat, and mink in the Eagle River drainage area should be reduced by the potential development.

Golden and bald eagles could suffer loss of nesting and hunting habitat as a result of deterioration of riparian habitat within the area. If this happens, the distribution of these raptor species within the Eagle River watershed would be affected.

The peregrine falcon's use of and distribution within the area also could be impacted by streamflow depletions and inundation of riparian habitat.

Construction activity and loss of habitat could impact the historic range of the Canadian lynx, wolverine, and river otter. Since the status of these three species within the study area is unknown, specific impacts to their habitat and abundance cannot be discussed.

The Williams Fork River watershed supports some of the best elk and mule deer habitat in the state. Accordingly, total harvest of these big-game species could be reduced by project development. The harvest of small game (e.g., snowshoe hare, blue grouse) could also be reduced. Similarly, destruction of riparian habitat could reduce furbearer populations, particularly beaver, muskrat, and mink, within the Williams Fork study area.

Hunting and nesting habitat of bald and golden eagles and the peregrine falcon within the Williams Fork study area could be reduced by project development, particularly destruction or degradation of the quality of riparian habitat.

Since the status of populations of Canadian lynx, wolverine, and river otter in the study area are not specifically known, impacts cannot be adequately addressed. However, project development could impact the historic ranges of these three species.

The discussion provided in Concept A regarding the status of endangered plants, amphibians, and reptiles in Colorado is applicable to Concept C.

Recreation, Socio-Economic, and Cultural. Expansion of the Williams Fork Collection System would deplete flows of the tributaries between Darling and McQueary Creeks; however, these creeks have no identifiable fisheries. Fishing opportunities would be reduced commensurate with the reduction in flows.

The overall reduction in flows and the installation of powerlines, the access road, and water conduits would detract from the aesthetic experience and reduce the quality of recreation for horseback riders, picnickers, hikers, and backpackers. However, the access road would provide greater back country accessibility for hunters.

South Fork Dam would provide a 160-surface-acre reservoir on the South Fork of the Williams Fork River. However, the dam and reservoir could essentially eliminate the trout fishery on this tributary, which is one of the better tributaries of the Williams Fork (Kelly 1976). It is anticipated the South Fork Reservoir water would be similar in

quality to that of the nearby Williams Fork Reservoir, i.e., "poor in summer and fair in fall" (Kelly 1976). The reason is reservoir fluctuation; stocking requirements would not be as great as in the more accessible reservoirs, and there would be little natural production. The reservoir would provide only shore fishing opportunities. some picnicking, and some camping.

Adverse impacts would also include a reduction in the availability of quality fishing streams in the area. Flows in the Williams Fork River would be reduced, and any migration of fish would be hindered by the structure. Therefore, fishing would be more concentrated in a smaller area rather than spread out, as it presently exists.

The Eagle River presently provides a diversity of recreation opportunities for canoes and rafts. Floating usually occurs during the spring and early summer runoff when there is sufficient water. The diversion of 67,000 acre-feet from the upper and lower Eagle River system could eliminate some seasonal river floating.

Eagle River depletion should not affect the excellent quality of fishing in the river, which is heavily stocked with rainbow and brown trout. The river flows could not fluctuate as much and conceivably could improve spring fishing.

Wolcott Dam and Reservoir on Alkali Creek would store up to 135,000 acre-feet and provide up to 1,505 surface acres for recreation. The recreation potential for the reservoir is good. However. a continuous nine-month drawdown beginning in July would curtail late summer. fall. and winter uses. The reservoir could provide a cold water fishery. which would help meet the needs for lake fishing in the area. Associated activities that could be developed include camping. picnicking. water skiing, and ice fishing. Concessionaires could conceivably rent boats for fishing, water skiing. and boating because the reservoir would be filling or near full during the peak recreation season.

Impacts of the construction of the Straight Creek facilities, disposal of tunnel muck, and enlargement of Gross Dam would probably exceed BLM criteria for maximum visual contrast. The nature of the impacts would be comparable to those described for similar elements of the proposed action.

The construction of South Fork and Wolcott Dams and Reservoirs would not require relocation of real property or people.

Since both the South Fork and Wolcott Reservoirs would experience seasonal drawdowns. adverse impacts to the overall scenic quality of those areas could be expected during winter months. No long-term

visual or aesthetic impacts to the Eagles Nest Wilderness Area would occur.

With completion of Wolcott Dam and Reservoir, the town of Wolcott and the immediate vicinity would experience a significant increase in tourist visitation. More service-related establishments would be built in and near Wolcott. Land speculators and developers would move in and acquire land adjacent to Wolcott Dam and Reservoir right-of-way lands. Zoning would be needed to control a haphazard proliferation of cabins, homes, and trailers. Sanitation problems could also arise.

The material excavated from the Wolcott-Dillon Tunnel would be disposed of on the edge of Dillon Reservoir (east portal disposal area). This disposal would create a new day-use area with potential recreational benefits. Visual and aesthetic values could be maintained by trimming and blending disposal materials with lands around the lake.

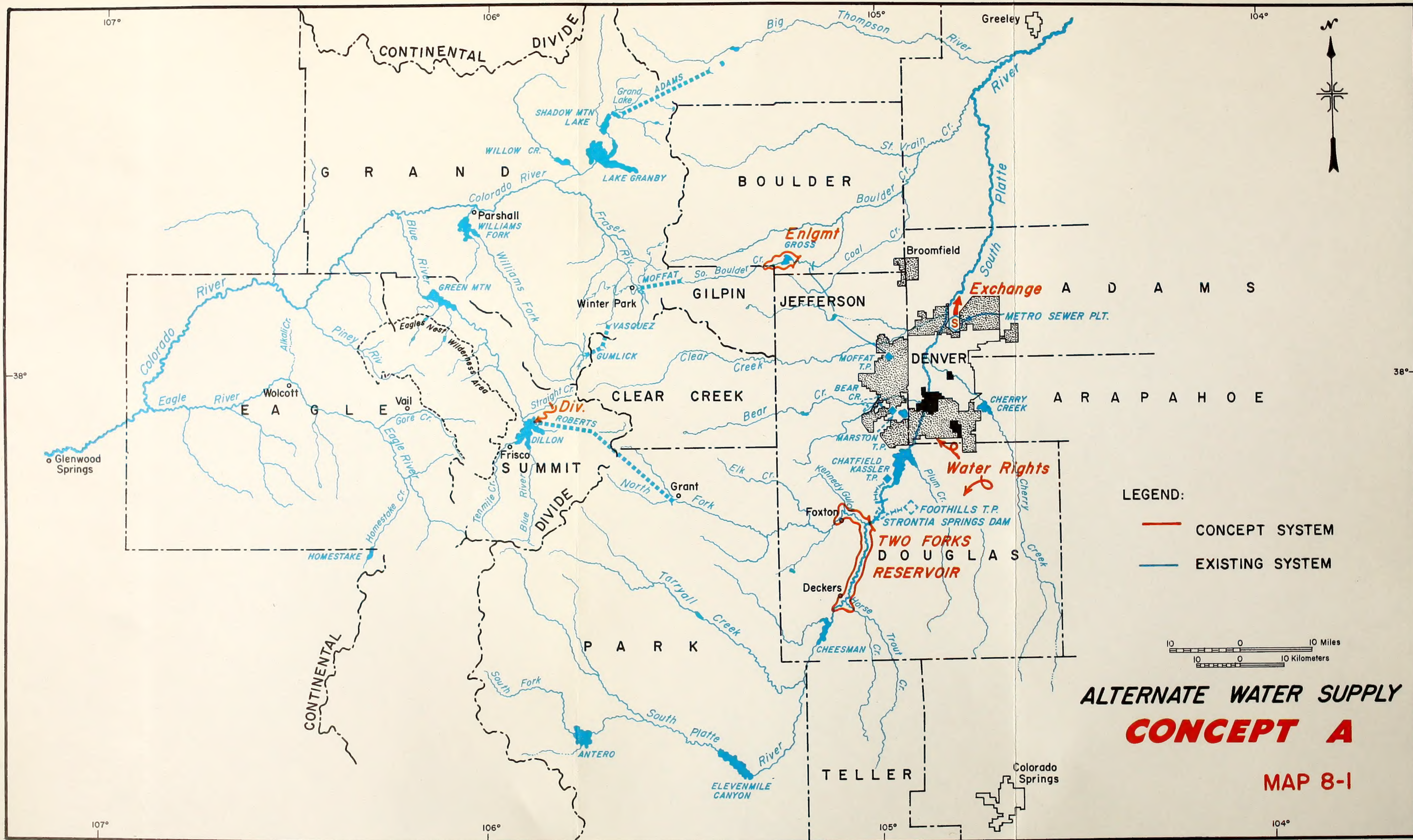
In terms of long-range energy impacts the 117 million kwh of energy annually required to pump Eagle River water into Dillon Lake would deplete coal reserves by about 59,000 tons a year.

The historic and prehistoric sites, if any, would be investigated were this concept to be activated, and appropriate measures, as described in the other concepts, would be undertaken to preserve or salvage these resources. As in portions of the other components, the beneficial effects of systematic mitigatory research would probably outweigh the adverse impacts on the archeologic resource base. The most negative effect would come from destruction of historic structures.

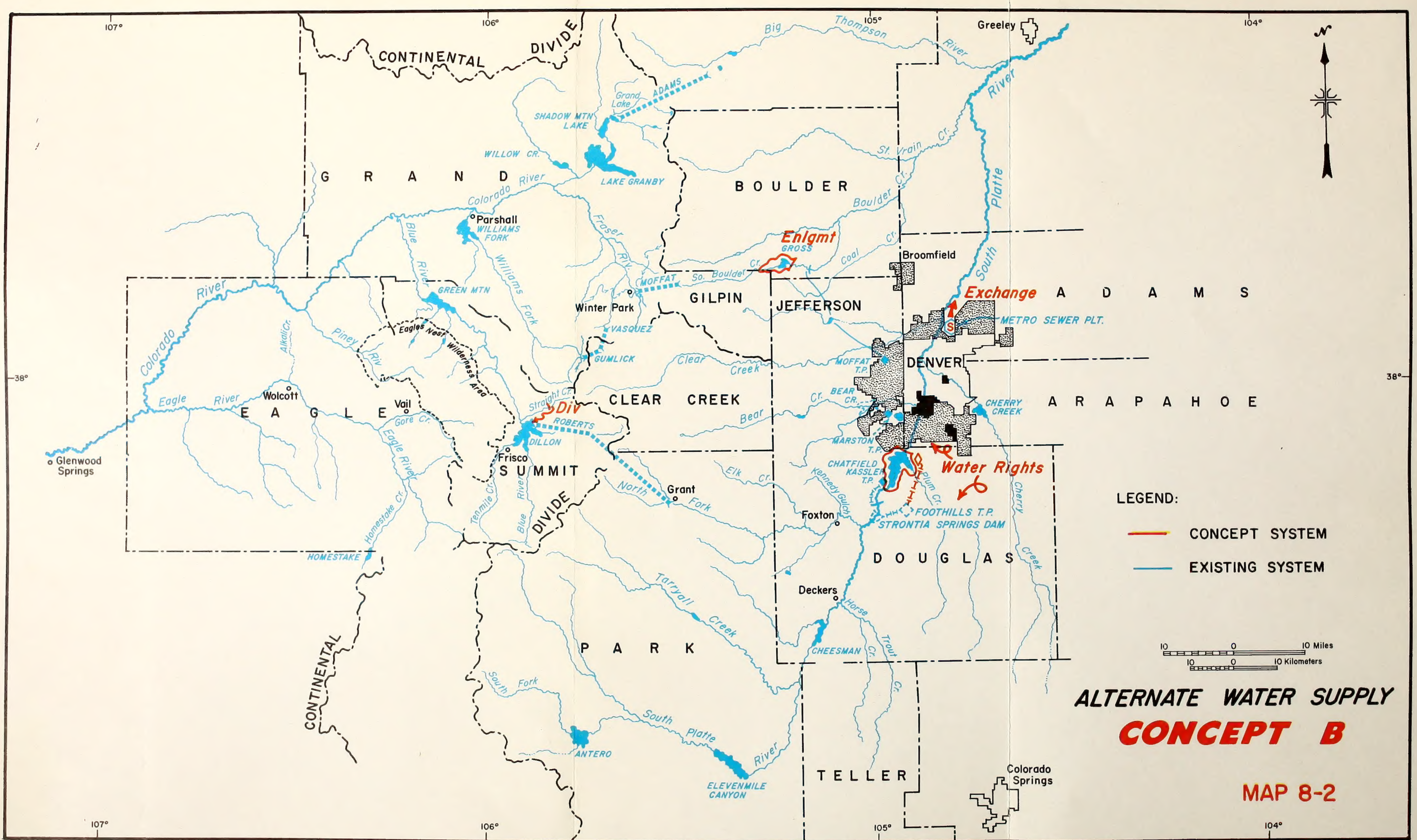
Because the area between South Platte, Colorado, and Pine, Colorado, is in the main area of the North Fork Historic District, a Determination of Effect pursuant to 36 CFR 800 would be required at such time that increased flows would cause impact to historic sites along the banks of the North Fork.

Since channel improvement is planned for segments of the North Fork, mitigation will be provided at that time. The responsibility for providing mitigation and/or Determination of Effect (Section 106) would be the responsibility of the U. S. Army Corps of Engineers (Section 404e).

At that time, the Corps of Engineers would be required to provide a 106 Determination of Effect for the State Historic Preservation Officer (SHPO) for comment and to the Advisory Council on Historic Preservation for comment prior to the implementation of any action that would cause impacts to the historic district or those properties along the North Fork that are determined eligible for the National Register of Historic Places.



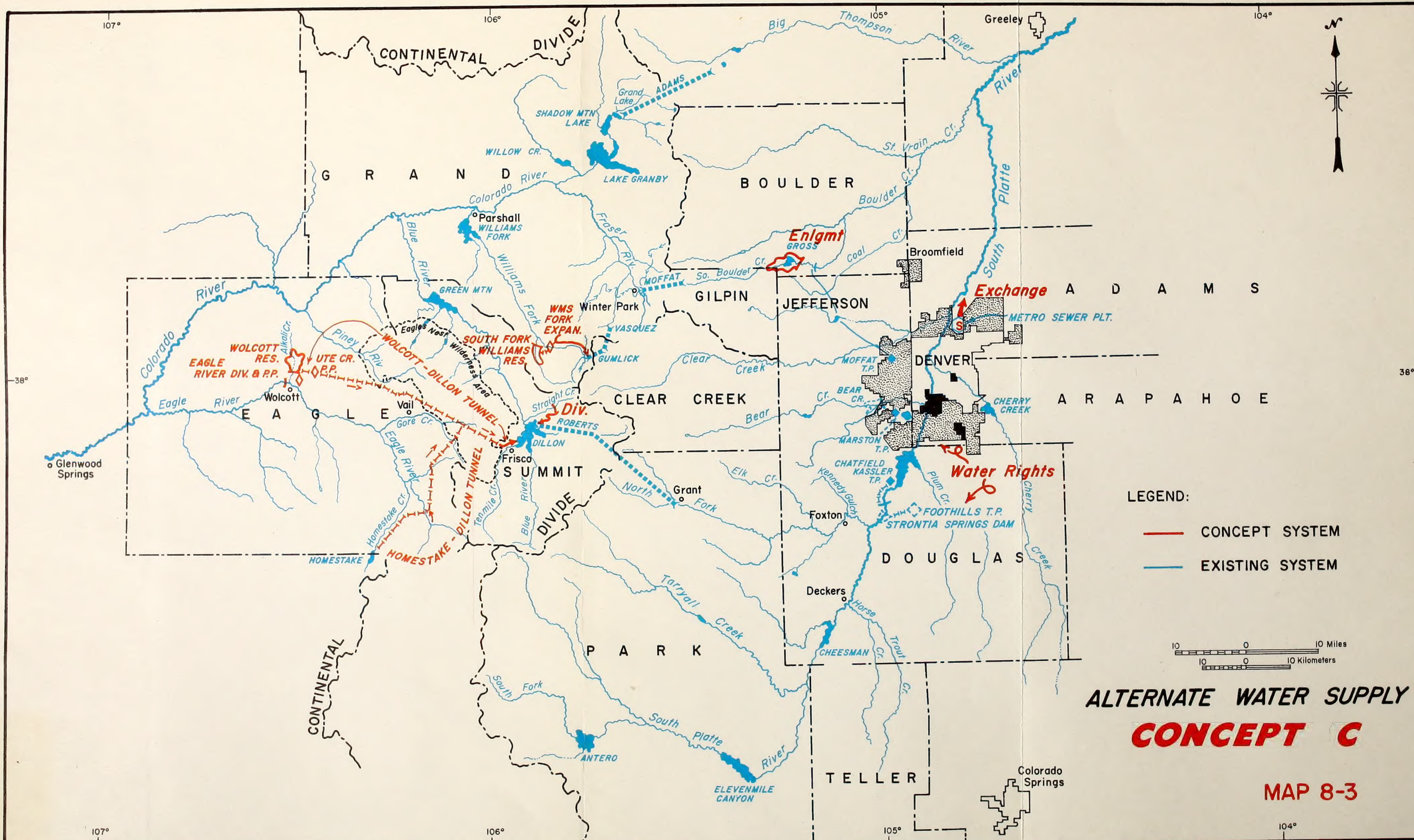
CONTINENTAL DIVIDE
GRAND
BOULDER
GILPIN
JEFFERSON
ADAMS
DENVER
ARAPAHOE
CLEAR CREEK
EAGLE
SUMMIT
DOUGLAS
PARK
TELLER
Greeley
Broomfield
Parshall
Winter Park
Wolcott
Vail
Frisco
Glenwood Springs
Grant
Foxton
Deckers
Colorado Springs
SHADOW MTN LAKE
LAKE GRANBY
ADAMS
WILLOW CR.
WILLIAMS FORK
GREEN MTN
MOFFAT
VASQUEZ
GUMLICK
ROBERTS
DILLON
HOMESTAKE
ANTERO
ELEVENMILE CANYON
CHEESMAN
MOFFAT T.P.
BEAR CR.
MARSTON T.P.
CHATFIELD KASSLER T.P.
FOOTHILLS T.P.
STRONTIA SPRINGS DAM
CHERRY CREEK
METRO SEWER PLT.
Enlgmt
GROSS
Div.
Exchange
Water Rights
TWO FORKS RESERVOIR
Eagles Nest Wilderness Area
LEGEND:
CONCEPT SYSTEM
EXISTING SYSTEM
10 0 10 Miles
10 0 10 Kilometers
ALTERNATE WATER SUPPLY
CONCEPT A
MAP 8-1



ALTERNATE WATER SUPPLY

CONCEPT B

MAP 8-2



ALTERNATE WATER SUPPLY

CONCEPT C

MAP 8-3